Appendix A–1:
Cape Fear Current, Water Level and WQ Study

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DATA REPORT

Cape Fear

Current, Water Level and Water Quality Study

March 27 – April 3, 2017

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CAPE FEAR RIVER

1.0 INTRODUCTION

This report documents a current and water quality measurements on the Cape Fear River in North Carolina conducted in the early spring of 2017. The measurement campaign consisted of two components: 1) the deployment of fixed instruments at two stations on the river to collect information on currents, water levels, salinity, Dissolved Oxygen (DO), and turbidity, and 2) the collection of current, salinity, DO, turbidity, and suspended solids data with vessel mounted instruments at three regions along the river. This report documents the field efforts related to the data collection along with the analysis and results of the data.

2.0 BOTTOM MOUNTS AND FIXED WATER QUALITY/LEVEL

Two stations were selected along the Cape Fear River to take measurements of currents, water levels, salinity, turbidity, DO and temperature. At each station, a bottom mount equipped with an upward facing ADCP and YSI EXO2 were deployed. In addition, a HOBO water pressure sensor and an YSI EXO2 were installed on a piling near the bottom-mount deployment site to measure water level and near surface water quality parameters.

2.1 South Station

The South Station was located near Southport, NC, at the lower end of the Cape Fear River as shown in Figure 1. A TRBM (Trawl Resistant Bottom Mount) was used due to potential trawling activity in the area. The mount was outfitted with a RDI Workhorse Sentinel 600kHz ADCP as shown in Photograph 1. The instrument was programed for 120 pings per ensemble at a 6 minute interval. The number of depth cells was set to 45 with a 50cm bin size. The mount also contained YSI EXO2 water quality sonde that was outfitted with temperature, pressure, conductivity, DO and turbidity sensors. The sonde was set for a 1 minute logging interval with an averaging duration of 8 seconds. A Benthos 866 acoustic release system was also installed in the mount. The mount was deployed on March 27 at 13:00 UTC (10:30 local time) at a depth of 45ft prior to the start of the vessel mounted current survey. The coordinates of the TRBM are provided in Table 1 below. .

As shown in Figure 1, the fixed water quality/ water level station was installed on a nearby piling on the same date at 12:30 UTC (08:30 local). The station contained an YSI EXO2 which was installed at a depth of approximately 3 feet below the average low water and set to collect temperature, pressure, conductivity, DO and turbidity at 1 minute intervals with an 8 second averaging. The station also had a HOBO water level sensor that was surveyed in to the NAVD88 vertical datum by a local surveyor following the installation. The coordinates for this station are provided in Table 1 below.

Table 1: South Station Locations

	Latitude	Longitude
TRBM	33.919826°	-78.002425°
Water Quality	33.920601°	-78.009407°

Recovery efforts for the mount began on the morning of April 1, 2017, following the completion of the vessel mounted current survey. Using a deck box and a transducer lowered over the side of the vessel, an acoustic signal was transmitted to the release system on the bottom mount. The deck box received a signal back from the release that had opened, however, no buoy surfaced. The field team then tried grappling for the ground line attached to the bottom mount for several hours, but was unsuccessful in catching it. A local dive team was organized and returned to the site on April 3, 2017. The dive team was able to locate the mount and bring it onboard the recovery vessel. An inspection of the bottom mount release system revealed that the recovery buoy line had become entangled had not been able to surface once the release signal had been received. The South water quality station was recovered April 1, 2017, at 11:45 UTC (7:45 local) without incident.

2.2 North Station

The North station was located near Wilmington, NC, in the upper portion of the anchorage basin north of the Port of Wilmington as shown in Figure 2. This location was selected after discussions with the Harbor Pilots indicated that this area was above the area where the deep draft ships operate and, therefore, would not be a hazard to navigation. A recent bathymetric survey of this area from the USACE indicated that the water depths in this area were uniform and there was no evidence of shoaling or significant accumulations of sediment.

An open mini mount was used at this location as shown in Photograph 2. The mount was outfitted with a RDI Workhorse Sentinel 1200kHz ADCP. The instrument was programed for 120 pings per ensemble at a 6 minute interval. The number of depth cells was set to 40 with a 50cm bin size. The mount also contained YSI EXO2 water quality sonde that was outfitted with temperature, pressure, conductivity, DO and turbidity sensors. The sonde was set for a 1 minute logging interval with an averaging duration of 8 seconds. A Benthos 866 acoustic release system was also installed in the mount. The mount was deployed on March 27 at 15:30 UTC (11:30 local time). The coordinates of the deployment site are provided in Table 2.

The fixed water quality/water level station was installed on a nearby piling on the same date at 15:05 UTC (11:05 local) as shown in Figure 2. The station contained an YSI EXO2 which was installed at a depth of approximately 3 feet below the average low water and was set to collect temperature, pressure, conductivity, DO and turbidity at 1 minute intervals with an 8 second averaging. The station also had a HOBO water level sensor that was surveyed in to the NAVD88 vertical datum by a local surveyor following the installation. An internal recording barometer was installed on the pier on which the water quality/water level station was mounted and collected data to correct the water level data for variations in barometric pressure. The coordinates of water quality/water level station are provided in Table 2.

Table 2: North Station Locations

	Latitude	Longitude
Mini Mount North	34.215695°	-77.954937°
Water Quality North	34.211865°	-77.95445°

The recovery for the North Station occurred on April 1, 2017. The deckbox was used to activate the acoustic release and the buoy surfaced shortly after the release command was sent. As the mount was brought alongside the recovery vessel it became apparent that the mount was completely covered in thick black mud. There was mud on top of the ADCP transducers and covering EXO sensor cage which was installed on the top of the mount as shown in Photograph 3. The presence of mud on top of the ADCP indicated that the mount had been completely submerged in the mud. This was confirmed when the instruments were downloaded and showed no viable data. The soft sediments at this location were significantly thicker than anticipated based on the February survey data and suggest that this was an area of rapid sedimentation and fluid mud.

The North water quality/ water level station and the barometer were recovered April 1st at 12:35 UTC (10:35 local) without incident.

3.0 CURRENT SURVEYS USING VESSEL MOUNTED ADCP

Currents were measured simultaneously in three regions of the Cape Fear River using three vessels equipped with downward looking ADCPs configured with bottom tracking. The three regions were Southport, Snows Cut, and Wilmington Harbor. In each region there were a series of transect lines that were established across the channel and the vessels collected currents along each transect. The set of lines were repeated as quickly as possible with the goal being to collect a set of data from each line approximately every hour. Measurements were collected for 10-12 hours each day on March 29 and March 30 and for approximately 6 hours on March 31.

The locations of the lines in each of the three regions are show in Figures 4, 5, and 6 (Southport, Snows Cut and Wilmington, respectively) and described in Table 3 below.

Table 3: Vessel Mounted ADCP Survey Regions

Southport	3 lines
Snows Cut	4 lines
Wilmington	3 lines at the primary measurement area located south of the Port of Wilmington and 3 lines at the secondary measurements area located near Downtown Wilmington

4.0 CTD CASTS AND WATER SAMPLING

CTD casts were performed using an YSI EXO sonde with temperature, pressure, DO, and turbidity sensors. A CTD cast was taken on each round of measurements at transect lines 6, 9, and 11 (see Figures 7, 8, and 9). The cast was taken at center of the channel except when water sampling was conducted, at which time casts were also done on the left and right sides of the channel approximately halfway up the side slope of the channel. The coordinates of the CTD stations are provided in Table 4.

Table 4:
Locations of CTD and Water Sampling Stations

Line	Location	Lat	Lon
6	Center	34.17537	-77.95826
6	Left	34.17538	-77.95741
6	Right	34.17534	-77.95937
9	Center	34.03993	-77.94064
9	Left	34.04004	-77.93841
9	Right	34.03993	-77.94279
11	Center	33.91418	-78.01415
11	Left	33.91335	-78.01343
11	Right	33.91572	-78.01545

Water samples were collected using a Niskin bottle along the same transect lines as the CTD casts (lines 6, 9, and 11). For each water sampling event, water samples were collected at one-third the water depth and two-thirds the water depth at the center of the transect and on either side of the channel approximately half way up the side slope of the channel. On the first day, three water sampling events took place in each survey region. These events were targeted to match max velocity of flood and ebb tides and high slack. On the second day, two sampling events took place in each sampling region and were targeted to occur at the maximum flood and ebb velocities.

5.0 PROCESSING AND RESULTS OF FIXED INSTRUMENTATION

The fixed instruments were deployed for six days which included the 3 –day period during which the vessel mounted current survey was conducted along the river. As discussed previously, the North Station bottom mounted ADCP and CTD did not collect any usable data due to being buried in mud. Therefore, the following section only discusses current data from the South Station location near Southport. Data from all the instrumentation was reviewed and analyzed using a combination of instrument manufacturer software and in-house analytical programs. Details of the processing approach for each of the sensors is provided below. Please note that all times provided are in UTC and directions are referenced to true North.

5.1 Bottom Mount Current Data from Southport ADCP

The current data was extracted for the raw binary files collected by the upward looking ADCP on the TRBM using Teledyne software and then further analyzed and processed using in-house analysis tools. In order to insure that the ADCP collected data from the entire water column, it was set to collect some bins that would be positioned above the water surface. The instrument will record data for these bins even though they are out of the water and often these data will appear reasonable. To cut the data above the water surface, the spike in the backscatter amplitude was used to determine which bin should be considered the last good bin. As a final step the data was visually inspected and any questionable data was flagged and marked as bad in the final data set.

5.1.1 Current data from ADCP

Plots of the current data from the South Station bottom mounted ADCP are provided in Appendix I. The data show that during ebb tides, the average max velocity reached speeds of approximately 170 – 190 cm/s. This was a higher magnitude then during flood tide when currents peaked at approximately 120 – 140 cm/s. Maximum surface currents exceeded 200 cm/s, while bottom currents were in the range of 70 – 100 cm/s. Current direction throughout the water column stayed consistent through each tide cycle (230° ebb tide and 50° flood tide). The processed current data is provided in the ASCII data file that accompanies this report. A description of the data contained in the file is provided in the file’s header information.

5.1.2 Ancillary data from ADCP

Plots of the ancillary and measurement quality data measured by the ADCP during the deployment are presented in Appendix II. This includes the water over the instrument, water temperature, instrument pitch, roll and heading, vertical velocity and signal amplitude. The pitch, roll and heading data indicate that after some initial settling, the instrument was stable over the course of the deployment. The signal amplitude looked good throughout the deployment with a limited number of spikes in the amplitude.

5.2 Water Level Data

Water level was collected using HOBO water level sensors on fixed mounts near Southport and Wilmington. As discussed previously, six full days of water level data was recovered from the water level sensors. This data was corrected for variations in barometric pressure and then an offset based on the survey information was applied to the data to adjust it to NAVD88. Plots of the corrected water level and water temperature are provided in Appendix III. The data shows semidiurnal tides in the area with two low and two high tides within a 24 hour period. The tidal range for both project areas is approximately 2 m.

5.3 Water Quality Data

Near bottom water quality data was collected at the South and North Stations with a sonde mounted on the top of the bottom mount, and near surface water quality data was collected with sondes mounted approximately 3 ft below mean low water on nearby pilings near the shoreline. Data was extracted from the EXO2 using YSI KOR-EXO software and then further analyzed and processed using in-house analysis tools. As noted previously, the sonde at the North Station was buried in mud and did not record any viable data and is therefore left out of the discussion. Results of the water quality measurements from the other sensors are presented in Appendix IV.

Temperature at the Southport remained fairly consistent between bottom and surface readings. At the time of deployment the temperature was at around 14°C and gradually climbed to approximately 17°C, with day time temperatures rising by 1.5°C. Salinity fluctuated with the tides. During peak flood tide salinity maxed at 32 – 34 PSU and gradually dropped to 26 – 28 PSU. Bottom measurements were slightly higher in salinity. Surface and bottom dissolved oxygen peaked at approximately 9 - 9.5 mg/L at the beginning of the deployment and gradually declining to under 7 mg/L. The surface DO showed more fluctuation than the bottom measurements and were generally higher. Turbidity fluctuated with the tides. Higher turbidity was associated with an outgoing tide and averaged around 25 FNU on the surface. Bottom turbidity was noisier and had two substantial peaks of over 75 FNU.

The North Station surface water quality data had similar patterns of the South Station. Temperatures began at 15.5°C and gradually rose to 18°C. Salinity peaked at 10 – 13 PSU during ebb and fell to 4 – 7 PSU at flood tide. Dissolved oxygen remained consistent at 8 mg/L. Turbidity fluctuated with the tide but for the most part remained under 25 FNU.

6.0 PROCESSING AND RESULTS OF DATA FROM VESSEL MOUNTED CURRENT SURVEY

6.1 Current Data Collected with Vessel Mounted ADCPs

The data collected during the current survey using the vessel-mounted ADCPs was processed using TRDI's WinRiver software and plotted using in-house software. As part of the processing, the data has had some horizontal averaging applied. A listing of all the transects collected and the associated file names is provided in a table in Appendix V. ASCII files of the processed data from each transect accompany this report.

Vertical contour plots of the data collected on each transect have been created and the plots for the 4 different areas; Southport, Snows Cut, Wilmington South of Port and Wilmington Downtown are provided in Appendices V. These plots provide an indication of the horizontal and vertical variations in the currents along the transects. As discussed previously, the ADCP cannot collect data near the surface or near the bottom, and, therefore, no data is shown in these areas. The contour plots have been oriented such that the left hand side of the plot is the left hand side of the channel headed out to sea. As can be seen can be seen in the contour plots, on some of the transects there were periods with data dropouts due to the excessive movement of the boat caused by waves from vessel traffic or weather conditions.

The ADCP data have also been depth averaged and are plotted as vector plots in plan-view in figures which cover each of the 4 survey regions and provided in Appendix VI. Please note that given the number of transects run, vector plot are only provided for the maximum flood and ebb conditions for each region on each day. Plots for additional time periods can be created upon request.

As part of the data collection, the ADCP software calculates the discharge across a transect using the measured velocities and the cross-sectional area. For the portions of the water column where it was not possible to collect data with the ADCP, the discharge values have been estimated by the ADCP by extrapolating the measured values into these areas. This includes estimates of the discharge in areas along the edge of the river between the end of the transect line and the shoreline. For those transects where there were large shallow flats between the end of the transect line and the shoreline, the discharge in these areas was not included in the overall discharge calculation reported. The discharge data is summarized in the table at the beginning of Appendix V. Plots of the discharge are provided in Appendix VII.

6.2 Water Sampling

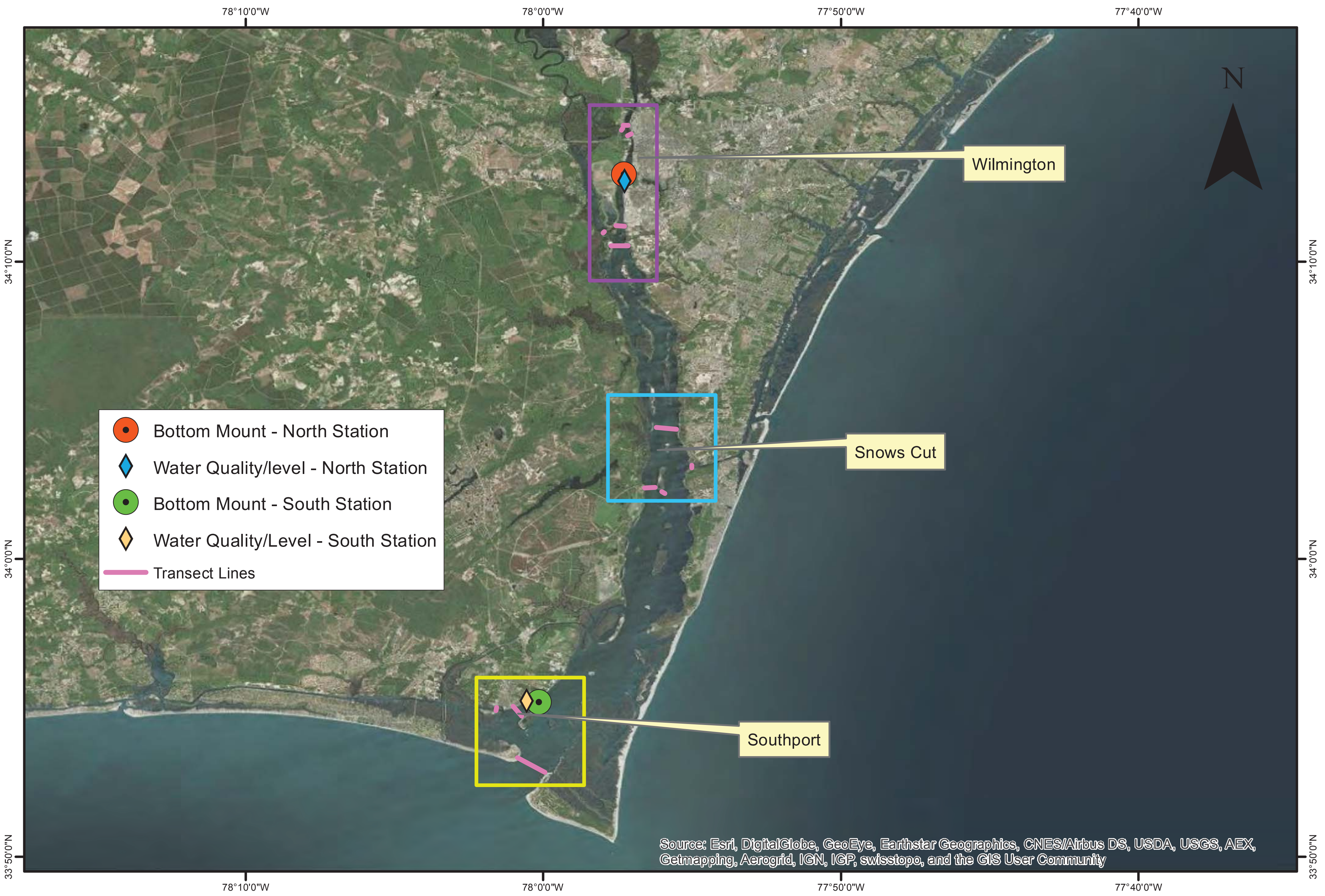
The water samples collected during the survey were analyzed for total suspended solids by a certified laboratory and the results of the analysis are provided in a table and plots in Appendix VIII.

Prior to submitting the water samples to the laboratory, the turbidity of the water in the samples was measured with the CTD that was used for casts at the transect where the water samples were collected. For the CTDs used on the fixed stations, similar measurements were also taken in the water samples collected nearest the stations. This data was then used to develop a linear correlation between the turbidity measured with the CTD and the TSS measured by the laboratory. Plots in Appendix VII show the results of this comparison for each of the CTDs. For some of the CTDs, there were instances where there were 1 or 2 data points that were significant outliers, and these points were excluded from the correlation analysis. Once the correlation between turbidity and TSS was established for each CTDs, it was used to estimate the TSS using the turbidity values from the CTD data.

6.3 CTD Casts

The CTD data from the casts collected during the current survey are provided in a table in Appendix IX. Plots of the data are also provided in Appendix IX and ASCII files of the data accompany this report. As discussed above, the TSS values shown in the plots are based on the correlations developed from the water sample data. Some smoothing has been applied to the data for plotting. The periodic gaps in the profile are the result of a buffering delay in the data collection software which caused the sonde to briefly stop data collection and clear the buffer.

Figures



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 1
Cape Fear Current Study
Project Area
March 27 - April 04, 2017

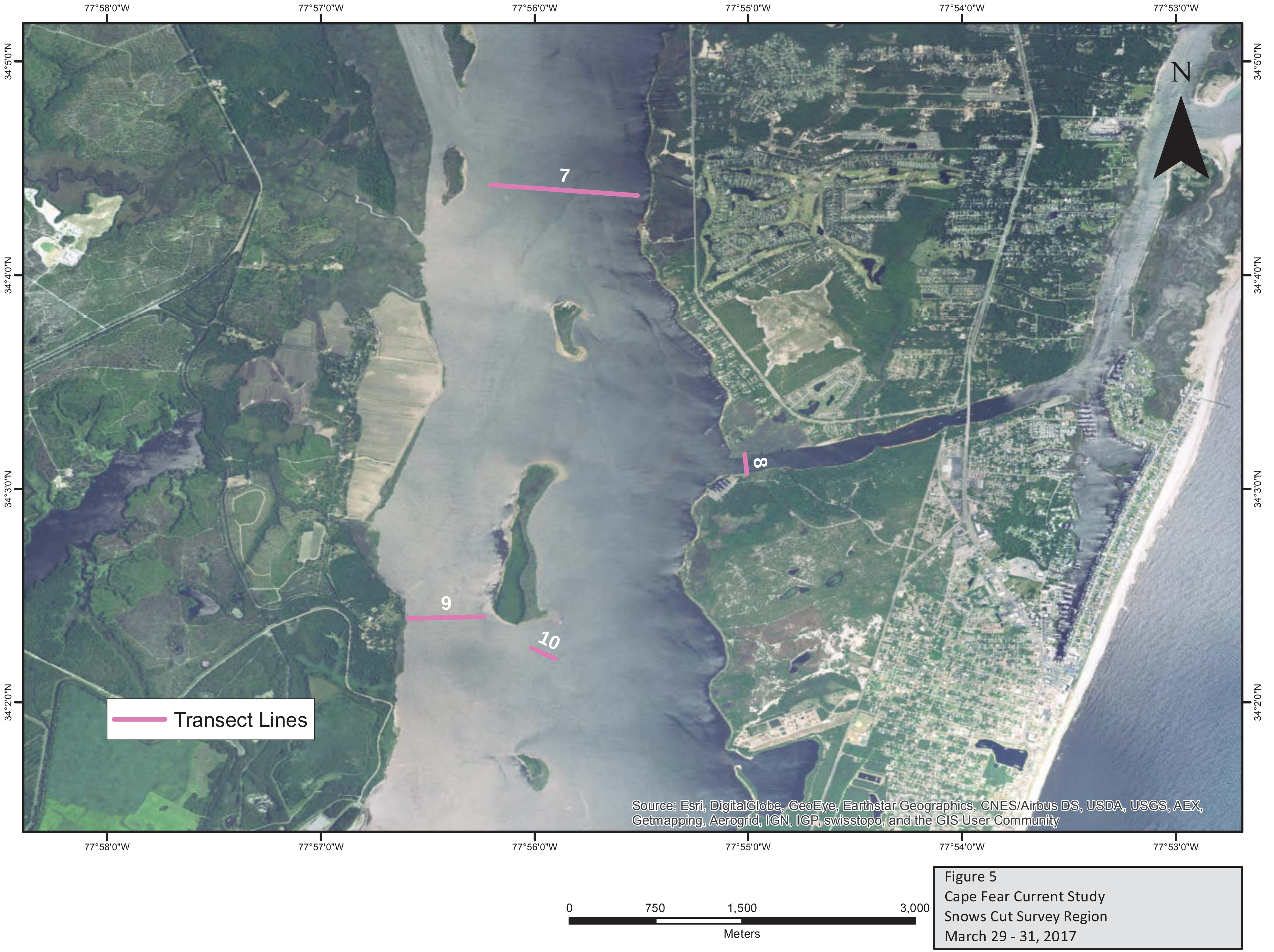
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 2
Cape Fear Current Study
Instrumentation Location - Southport Station
March 27 - April 04, 2017

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 3
Cape Fear Current Study
Instrumentation Location - North Station
March 27 - April 02, 2017

Figure 4
Cape Fear Current Study
Southport Survey Region
March 29 - 31, 2017

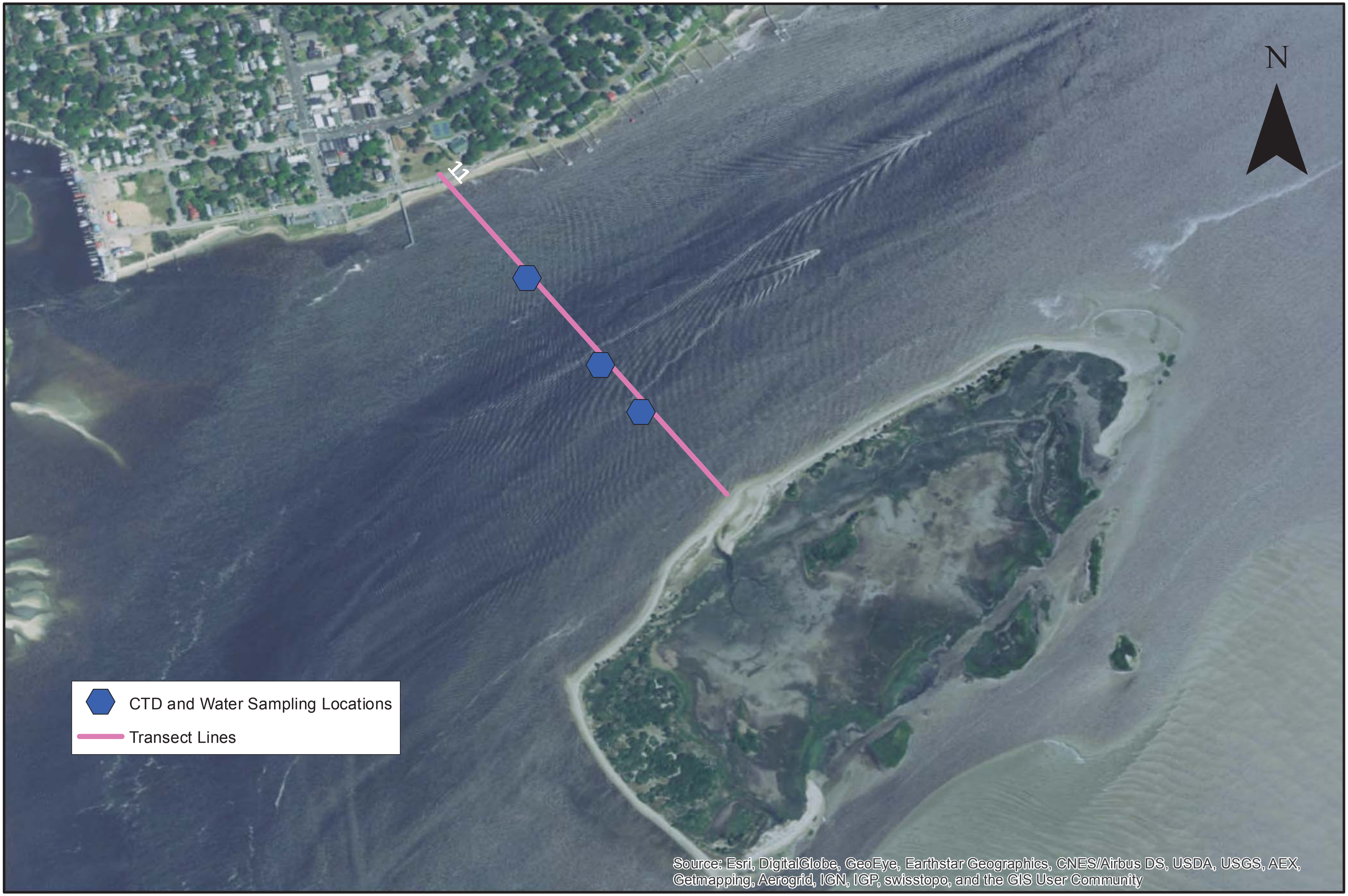


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 5
Cape Fear Current Study
Snows Cut Survey Region
March 29 - 31, 2017

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 6
Cape Fear Current Study
Wilmington Survey Region
March 29 - 31, 2017



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 7
Cape Fear Current Study
CTD and Water Sampling Stations - Southport
March 29 - 30, 2017

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 8
Cape Fear Current Study
CTD and Water Sampling Stations - Snows Cut
March 29 - 30, 2017

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 9
Cape Fear Current Study
CTD and Water Sampling Stations - Wilmington
March 29 - 30, 2017

Photographs

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1 TRBM Predeployment

2 Mini Mount Predeployment

3 Mini Mount Post Deployment

Photo 1: TRBM predeployment

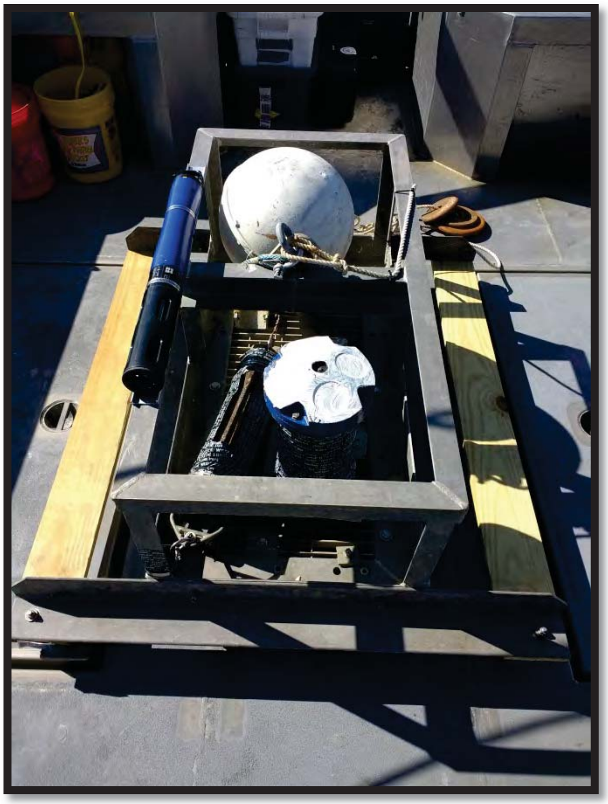
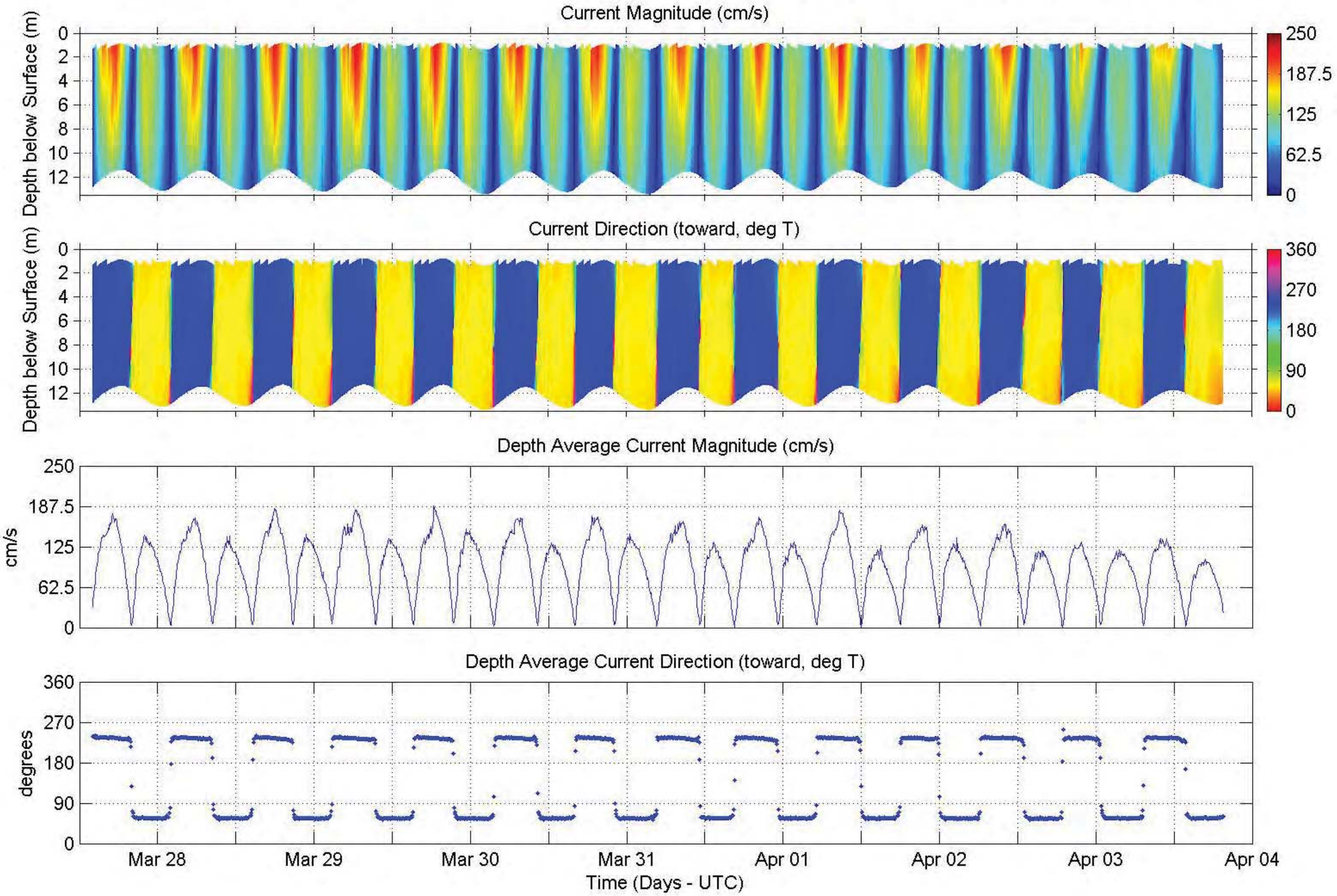


Photo 2: Mini mount predeployment

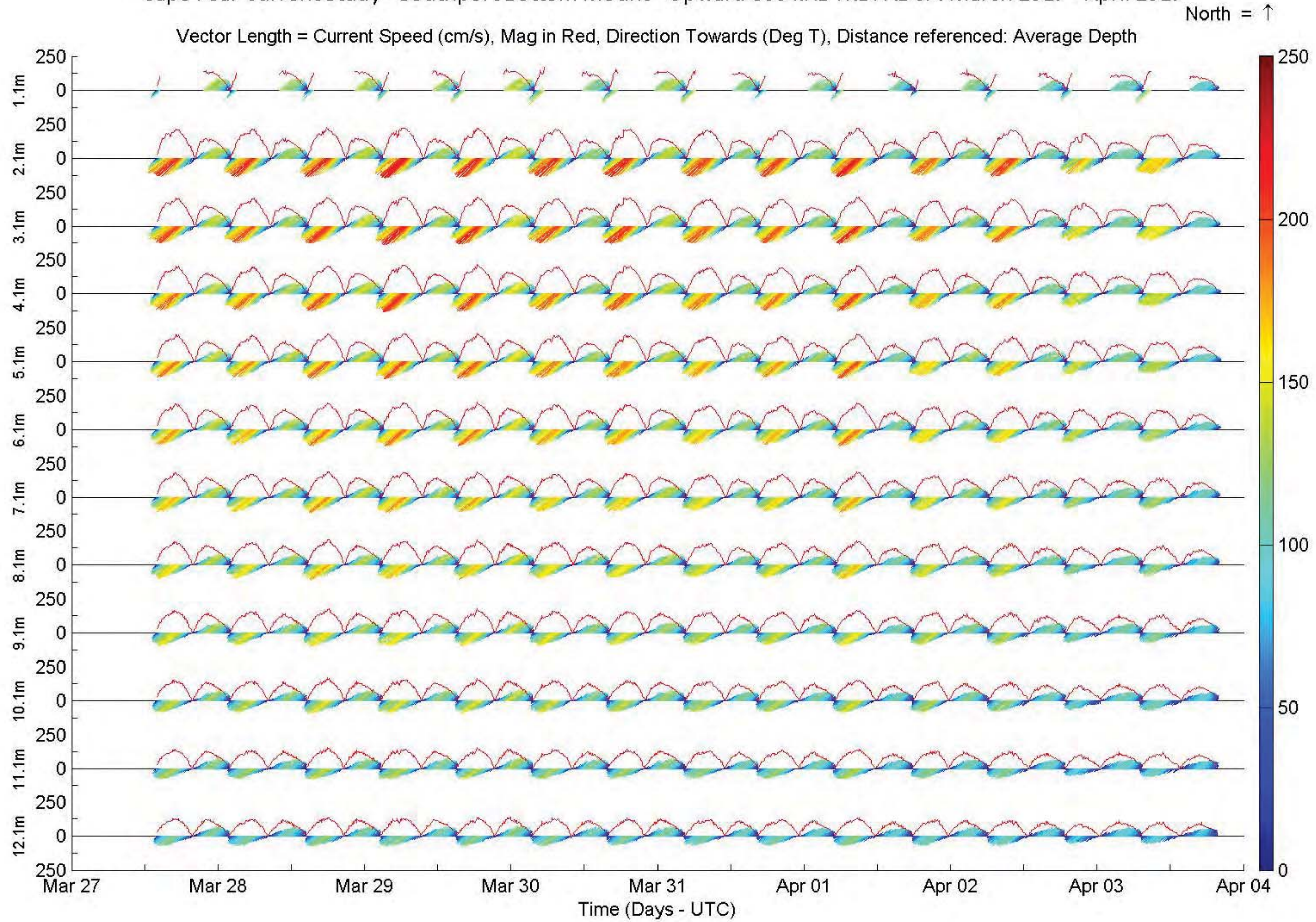
Photo 3: Mini mount post deployment

APPENDIX I Currents from Bottom Mounted ADCP South Station

Cape Fear Current Study - Southport Bottom Mount - Upward 600 kHz TRDI ADCP: March 27, 2017 - April 04, 2017



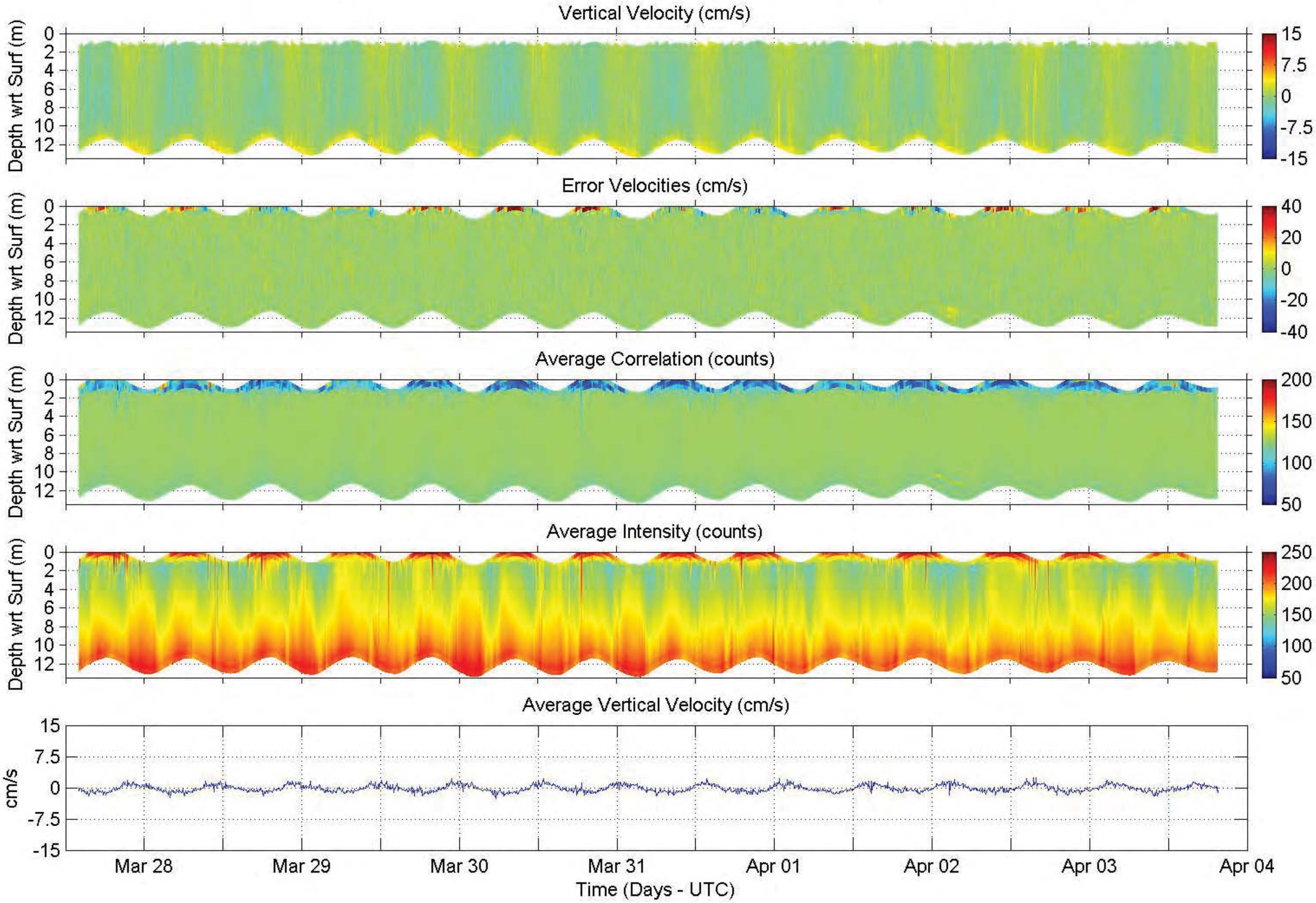
Cape Fear Current Study - Southport Bottom Mount - Upward 600 kHz TRDI ADCP: March 2017 - April 2017



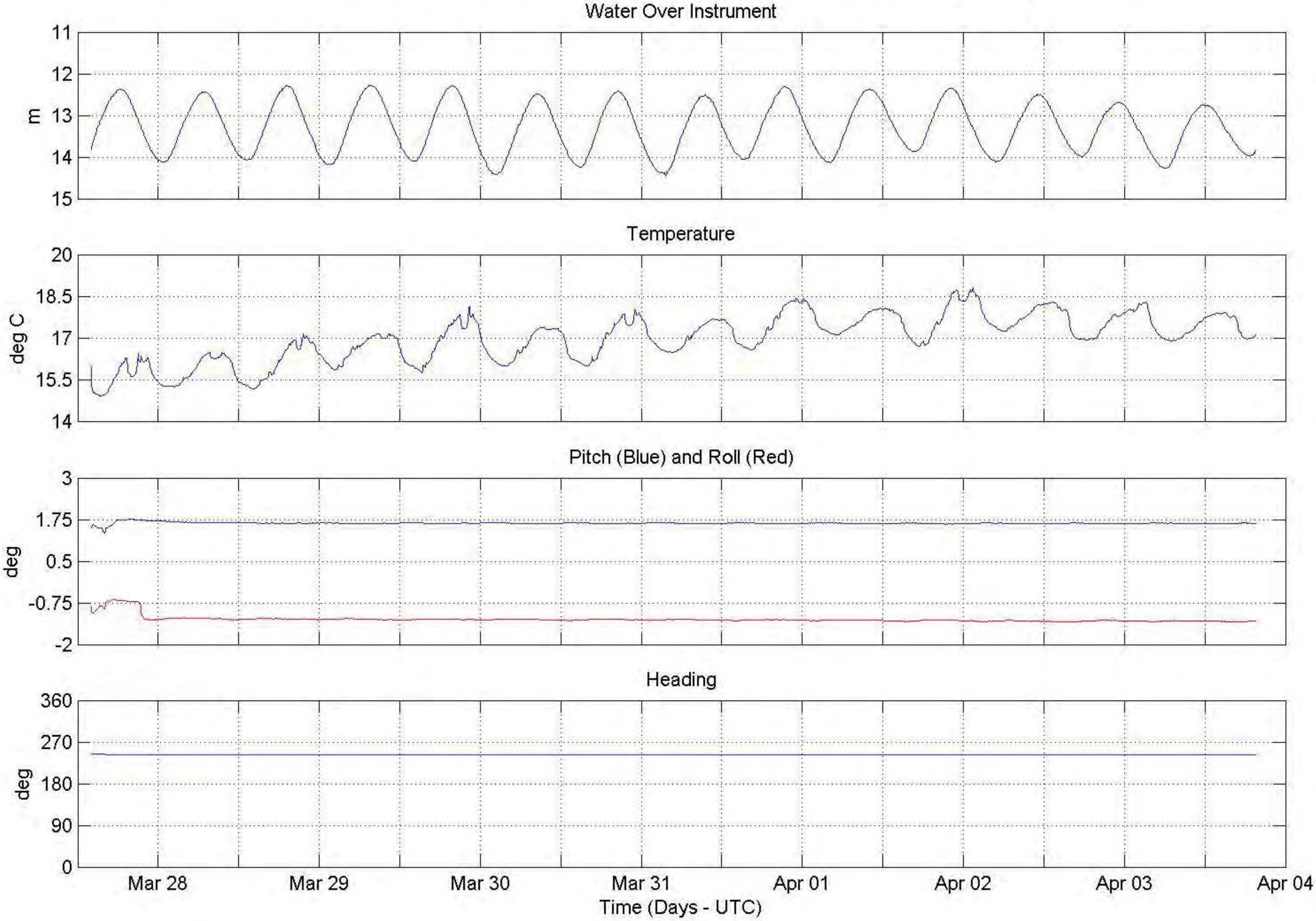
Vector Length = Current Speed (cm/s), Mag in Red, Direction Towards (Deg T), Distance referenced: Average Depth

APPENDIX II Data Quality Parameters and Ancillary Data from Bottom Mounted ADCP South Station

Cape Fear Current Study - Southport Bottom Mount - Upward 600 kHz TRDI ADCP: March 27, 2017 - April 04, 2017

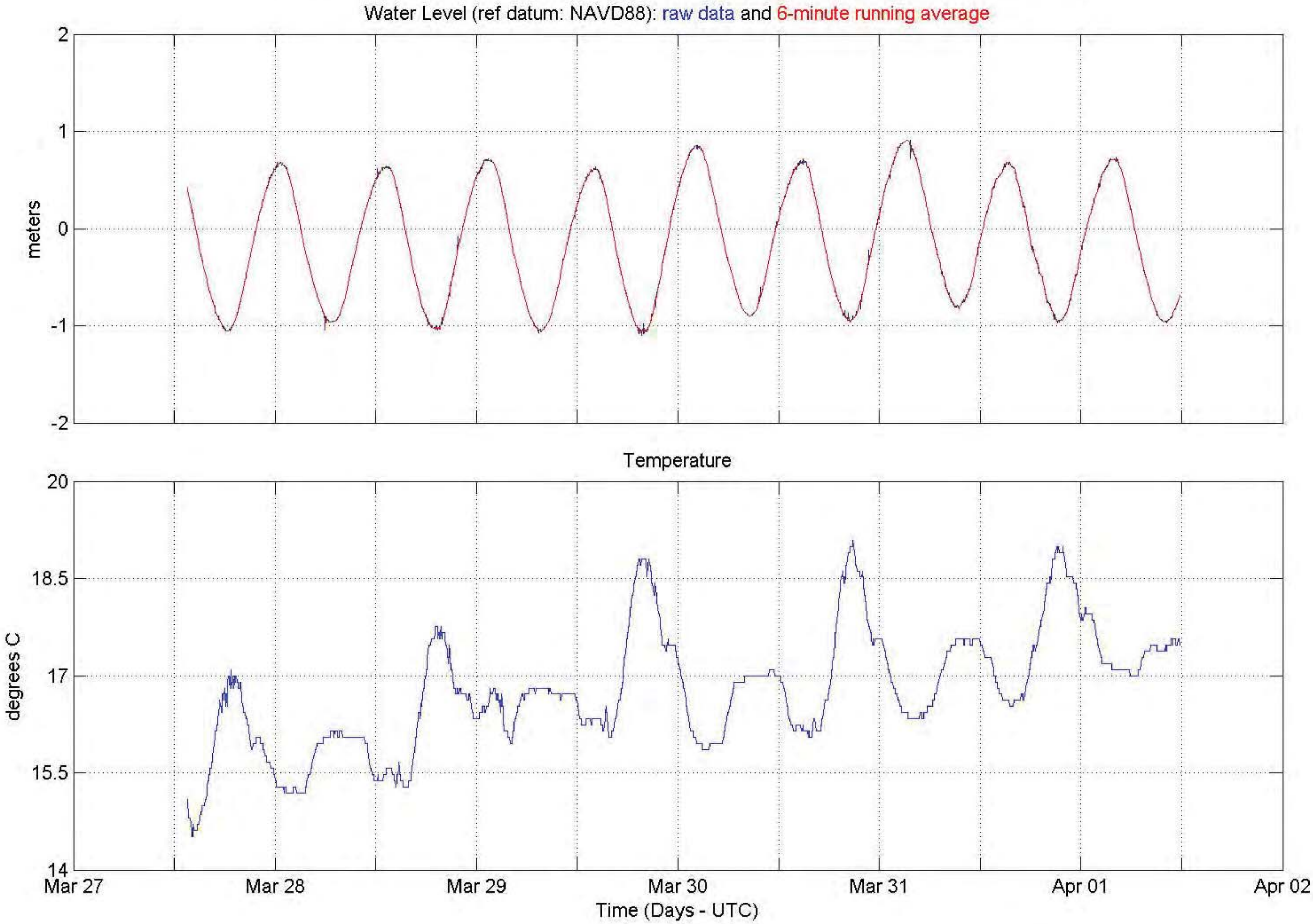


Cape Fear Current Study - Southport Bottom Mount - Upward 600 kHz TRDI ADCP: March 27, 2017 - April 04, 2017

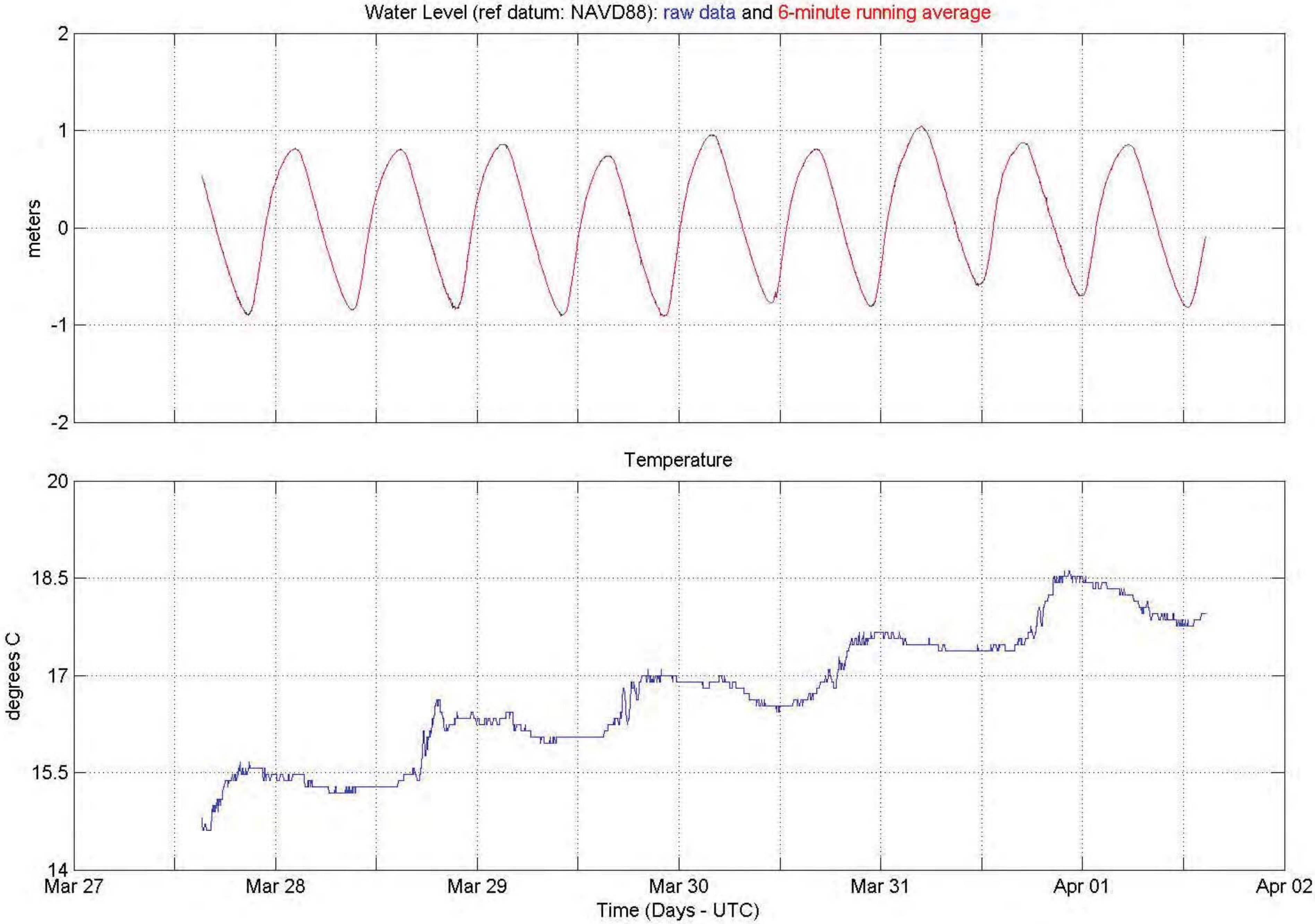


APPENDIX III Water Level Data from South Station and North Station

Cape Fear Current Study - Southport Water Quality - HOBO Logger: March 2017

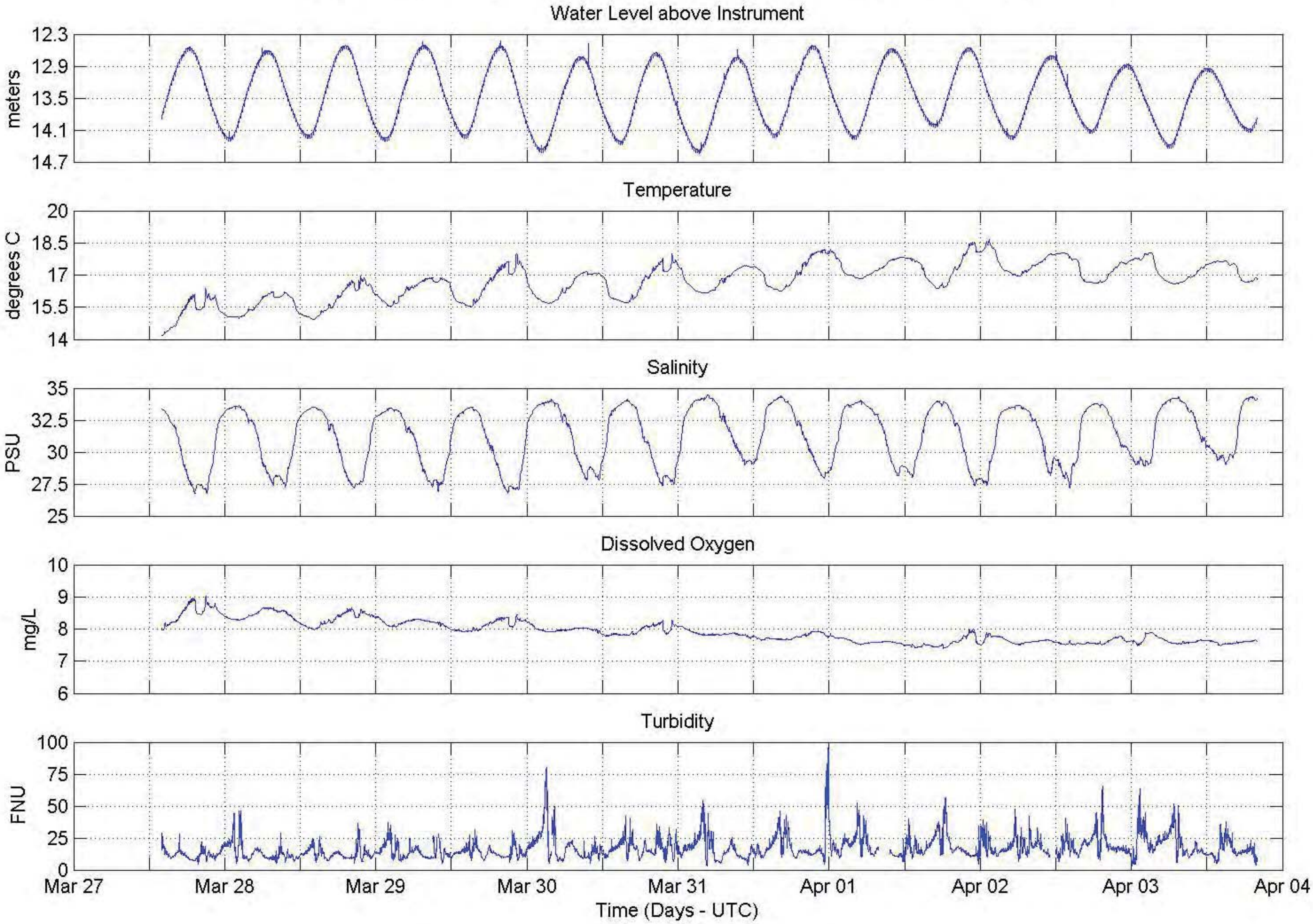


Cape Fear Current Study - Wilmington Water Quality - HOBO Logger: March 2017

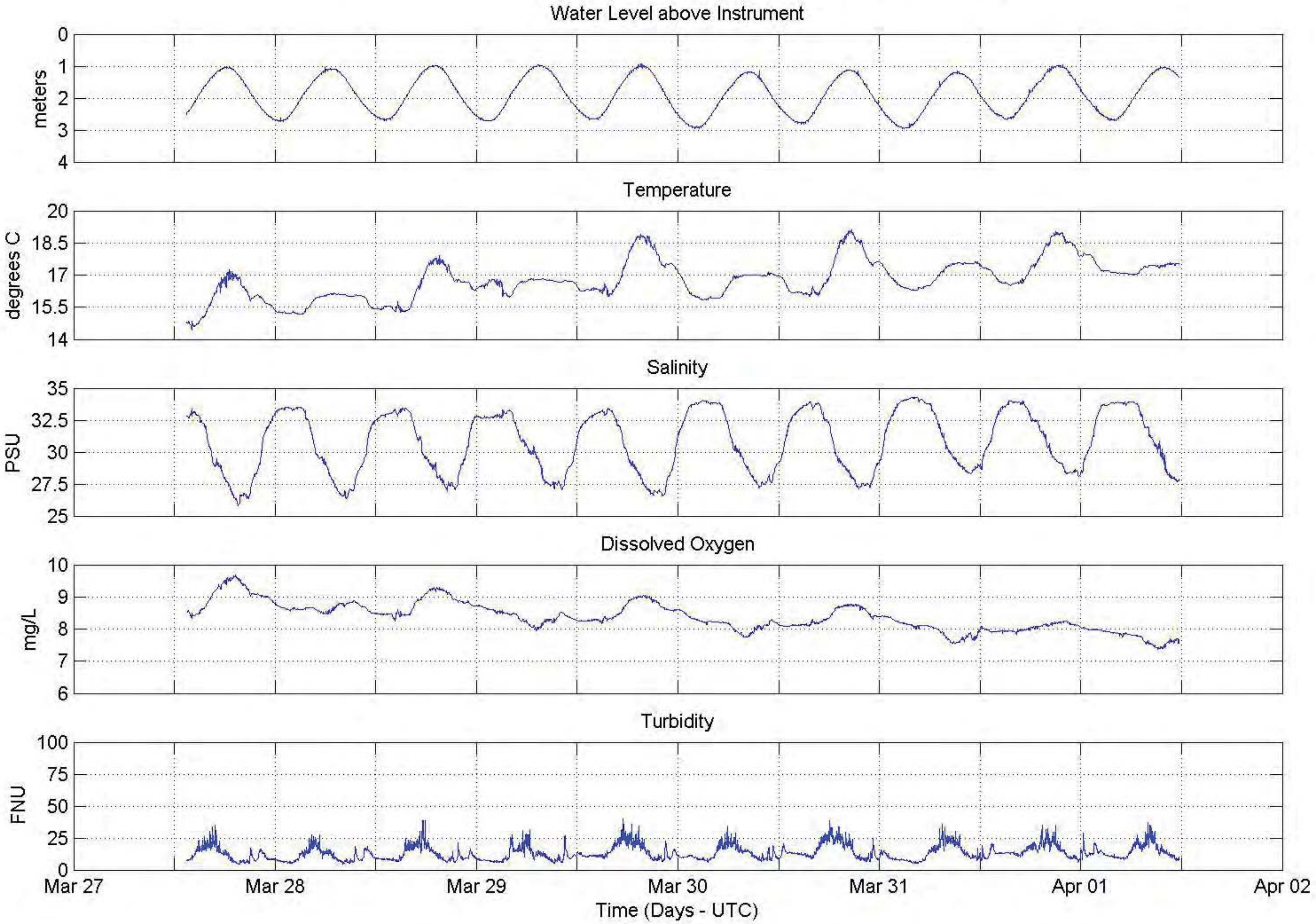


APPENDIX IV Water Quality Data from South Station and North Station

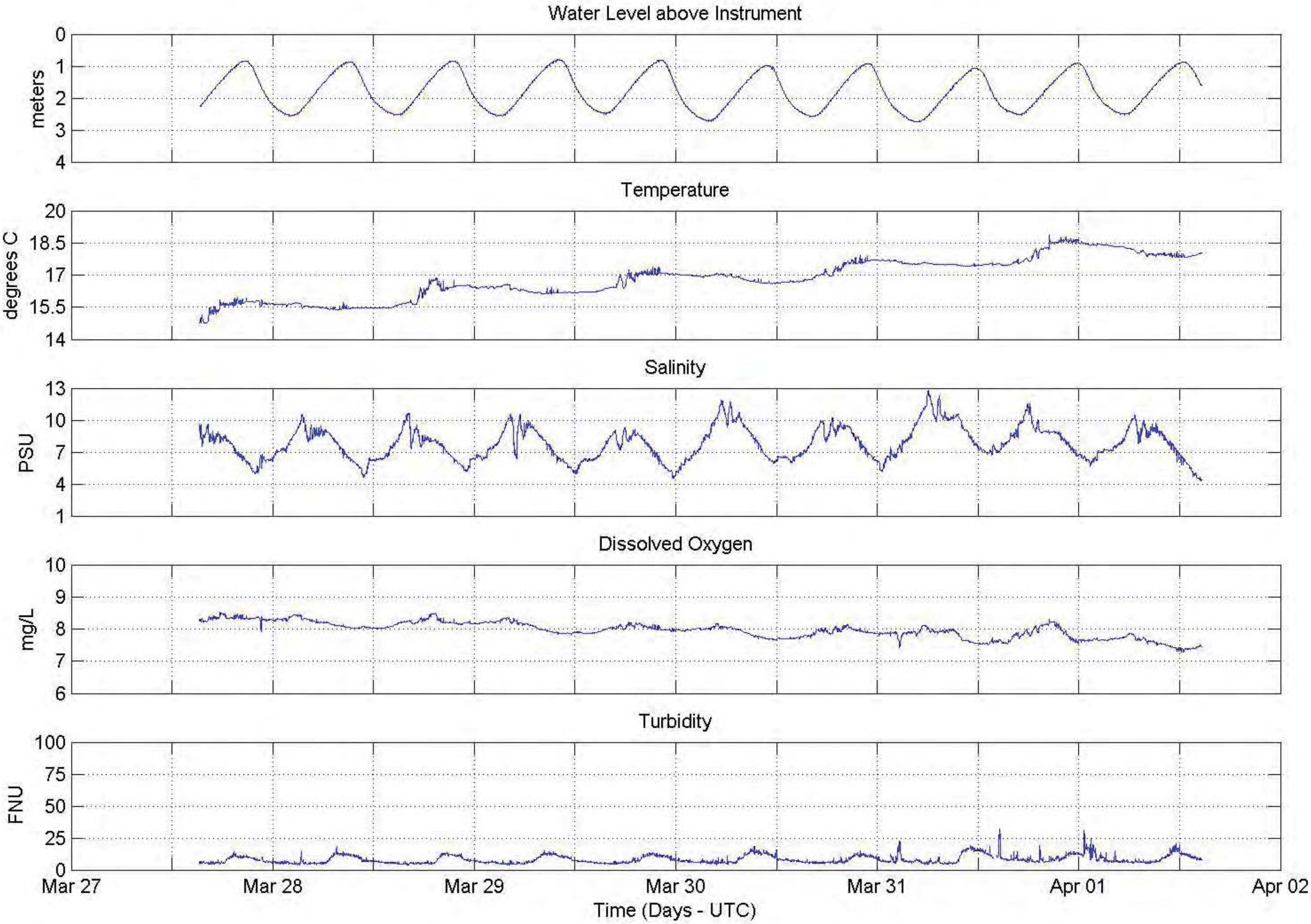
Cape Fear Current Study - Southport Bottom Mount - YSI CTD: March 2017



Cape Fear Current Study - Southport Water Quality - YSI CTD: March 2017



Cape Fear Current Study - Wilmington Water Quality - YSI CTD: March 2017



APPENDIX V Vessel Mounted Current Survey Contour Plots

Southport Transect Table

File Name	Round Number	Transect Number	Date	Start Time	Total Discharge (m^3/s)
Southport_0_001_2017032911194	1	11	3/29/2017	11:33	-6947
Southport_0_004_2017032913054	2	11	3/29/2017	13:17	-5920.7
Southport_0_007_2017032914523	3	11	3/29/2017	15:03	-306.1
Southport_0_012_2017032916211	4	11	3/29/2017	16:21	5868
Southport_0_015_2017032917333	5	11	3/29/2017	17:46	7332.1
Southport_0_019_2017032919065	6	11	3/29/2017	19:14	6592.5
Southport_0_022_2017032920564	7	11	3/29/2017	21:06	1609.3
Southport_0_026_2017032922495	8	11	3/29/2017	22:57	-7235.2
Southport_0_030_2017033011065	9	11	3/30/2017	11:16	-5459.8
Southport_0_033_2017033012380	10	11	3/30/2017	12:46	-7017.8
Southport_0_037_2017033014195	11	11	3/30/2017	14:29	-4993.5
Southport_0_040_2017033016005	12	11	3/30/2017	16:13	1829.6
Southport_0_043_2017033017140	13	11	3/30/2017	17:22	6321.2
Southport_0_046_2017033018304	14	11	3/30/2017	18:40	7187.3
Southport_0_049_2017033019393	15	11	3/30/2017	19:54	6617.2
Southport_0_052_2017033021082	15	11	3/30/2017	21:16	3712.9
Southport_0_055_2017033021574	17	11	3/30/2017	22:05	110.4
Southport_0_059_2017033111002	18	11	3/31/2017	11:08	76.2
Southport_0_062_2017033111503	19	11	3/31/2017	12:00	-4814.1
Southport_0_000_2017032911122	1	12	3/29/2017	11:18	-230
Southport_0_003_2017032912385	2	12	3/29/2017	13:04	-251.8
Southport_0_006_2017032914320	3	12	3/29/2017	14:51	213.2
Southport_0_009_2017032915460	4	12	3/29/2017	16:09	357.6
Southport_0_014_2017032917084	5	12	3/29/2017	17:32	244.4
Southport_0_018_2017032918485	6	12	3/29/2017	19:06	177.2
Southport_0_021_2017032920404	7	12	3/29/2017	20:55	-91.3
Southport_0_024_2017032922210	8	12	3/29/2017	22:34	-254.4
Southport_0_029_2017033011040	9	12	3/30/2017	11:05	-224.5
Southport_0_032_2017033012223	10	12	3/30/2017	12:37	-259.9
Southport_0_036_2017033014015	11	12	3/30/2017	14:18	-145.1
Southport_0_039_2017033015073	12	12	3/30/2017	15:59	342.4
Southport_0_042_2017033016563	13	12	3/30/2017	17:12	343.3
Southport_0_045_2017033018102	14	12	3/30/2017	18:29	232
Southport_0_048_2017033019221	15	12	3/30/2017	19:38	173.5
Southport_0_051_2017033020583	16	12	3/30/2017	21:07	13.4
Southport_0_054_2017033021482	17	12	3/30/2017	21:56	-134.2
Southport_0_058_2017033110573	18	12	3/31/2017	10:59	-97.6
Southport_0_061_2017033111375	19	12	3/31/2017	11:49	-223.8
Southport_0_002_2017032911414	1	13	3/29/2017	12:20	-11414.7
Southport_0_005_2017032913243	2	13	3/29/2017	14:19	-3067.2
Southport_0_008_2017032915092	3	13	3/29/2017	15:31	7428.8
Southport_0_013_2017032916274	4	13	3/29/2017	16:51	9996.3
Southport_0_017_2017032918280	5	13	3/29/2017	18:34	8558.5
Southport_0_020_2017032919214	6	13	3/29/2017	20:29	3364
Southport_0_023_2017032921104	7	13	3/29/2017	22:10	-8201
Southport_0_031_2017033011223	9	13	3/30/2017	12:12	11040.1
Southport_0_035_2017033013473	10	13	3/30/2017	13:49	-10391.4
Southport_0_038_2017033014360	11	13	3/30/2017	14:56	-4271.8
Southport_0_041_2017033016184	12	13	3/30/2017	16:40	9084.5
Southport_0_044_2017033017282	13	13	3/30/2017	17:50	10317.2
Southport_0_047_2017033018471	14	13	3/30/2017	19:08	8874.5
Southport_0_050_2017033019591	15	13	3/30/2017	20:46	4896.2
Southport_0_053_2017033021220	16	13	3/30/2017	21:37	467.1
Southport_0_056_2017033022091	17	13	3/30/2017	22:22	-4590.1
Southport_0_060_2017033111124	18	13	3/31/2017	11:27	-5166.3
Southport_0_063_2017033112050	19	13	3/31/2017	12:21	-9727.7

Snow's Cut Transect Table

File Name	Round Number	Transect Number	Date	Start Time	Total Discharge (m^3/s)
Snow_cut_0_007_2017032912140	1	7	3/29/2017	13:38	-3643
Snow_cut_0_012_2017032914334	2	7	3/29/2017	15:00	-2449.2
Snow_cut_0_016_2017032915433	3	7	3/29/2017	16:32	1914.5
Snow_cut_0_021_2017032917235	4	7	3/29/2017	17:40	3887.4
Snow_cut_0_025_2017032918453	5	7	3/29/2017	19:41	3976.3
Snow_cut_0_029_2017032920315	6	7	3/29/2017	20:56	3250
Snow_cut_0_033_2017032921444	7	7	3/29/2017	22:08	445.8
Snow_cut_01__0_001_2017033012033	9	7	3/30/2017	12:28	-4385.2
Snow_cut_01__0_005_2017033013093	10	7	3/30/2017	14:19	-3743.1
Snow_cut_01__0_012_2017033015374	11	7	3/30/2017	15:38	-2690.7
Snow_cut_01__0_016_2017033016171	12	7	3/30/2017	16:36	-465
Snow_cut_01__0_021_2017033017222	13	7	3/30/2017	17:42	2818
Snow_cut_01__0_026_2017033018295	14	7	3/30/2017	18:51	4021.5
Snow_cut_01__0_031_2017033019361	15	7	3/30/2017	20:42	3720.9
Snow_cut_01__0_035_2017033021312	16	7	3/30/2017	21:49	2791.2
Snow_cut_01__0_039_2017033022363	17	7	3/30/2017	22:52	135.8
Snow_cut_01__0_043_2017033111225	18	7	3/31/2017	11:39	1017.3
Snow_cut_01__0_047_2017033112383	19	7	3/31/2017	12:54	-3648.7
Snow_cut_01__0_051_2017033115050	20	7	3/31/2017	15:26	-3327.5
Snow_cut_01__0_055_2017033116173	21	7	3/31/2017	16:35	-2002.7
Snow_cut_01__0_059_2017033117171	22	7	3/31/2017	17:36	1308.7
Snow_cut_0_003_2017032910364	1	8	3/29/2017	11:32	375.1
Snow_cut_0_009_2017032914085	2	8	3/29/2017	14:11	144.6
Snow_cut_0_013_2017032915075	3	8	3/29/2017	15:22	-372.4
Snow_cut_0_018_2017032916573	4	8	3/29/2017	16:59	-313.8
Snow_cut_0_022_2017032917482	5	8	3/29/2017	17:59	-226
Snow_cut_0_026_2017032919492	6	8	3/29/2017	20:07	-89.6
Snow_cut_0_030_2017032921033	7	8	3/29/2017	21:19	272.6
Snow_cut_0_034_2017032922145	8	8	3/29/2017	22:29	402.1
Snow_cut_0_038_2017032923080	9	8	3/30/2017	11:12	393
Snow_cut_01__0_002_2017033012345	10	8	3/30/2017	12:47	422
Snow_cut_01__0_007_2017033014383	11	8	3/30/2017	14:39	273
Snow_cut_01__0_013_2017033015451	12	8	3/30/2017	15:55	-384.2
Snow_cut_01__0_018_2017033016564	13	8	3/30/2017	16:58	-389.9
Snow_cut_01__0_023_2017033018012	14	8	3/30/2017	18:02	-301
Snow_cut_01__0_028_2017033019102	15	8	3/30/2017	19:13	-238.8
Snow_cut_01__0_032_2017033020492	16	8	3/30/2017	21:07	-56.4
Snow_cut_01__0_036_2017033021555	17	8	3/30/2017	22:13	310.2
Snow_cut_01__0_040_2017033022590	18	8	3/31/2017	10:58	233.7
Snow_cut_01__0_044_2017033111472	19	8	3/31/2017	12:12	393.3
Snow_cut_01__0_048_2017033113005	20	8	3/31/2017	13:11	345.4
Snow_cut_01__0_052_2017033115340	21	8	3/31/2017	15:46	-231.5
Snow_cut_01__0_056_2017033116423	22	8	3/31/2017	16:55	-531
Snow_cut_0_006_2017032912011	1	9	3/29/2017	12:08	-3791.6
Snow_cut_0_011_2017032914245	2	9	3/29/2017	14:29	-2745.9
Snow_cut_0_015_2017032915343	3	9	3/29/2017	15:38	-980.1
Snow_cut_0_020_2017032917105	4	9	3/29/2017	17:19	2914.9
Snow_cut_0_024_2017032918290	5	9	3/29/2017	18:40	3765.5
Snow_cut_0_028_2017032920173	6	9	3/29/2017	20:27	3530.8
Snow_cut_0_032_2017032921300	7	9	3/29/2017	21:40	2058.2
Snow_cut_0_036_2017032922394	8	9	3/29/2017	22:44	-2022.3
Snow_cut_01__0_000_2017033011562	9	9	3/30/2017	11:59	-3326.8

Snow's Cut Transect Table

File Name	Round Number	Transect Number	Date	Start Time	Total Discharge (m^3/s)
Snow_cut_01__0_004_2017033012580	10	9	3/30/2017	13:05	3892.4
Snow_cut_01__0_010_2017033015034	11	9	3/30/2017	15:08	-2971.9
Snow_cut_01__0_015_2017033016043	12	9	3/30/2017	16:11	-1645.9
Snow_cut_01__0_020_2017033017090	13	9	3/30/2017	17:17	-1386.8
Snow_cut_01__0_025_2017033018134	14	9	3/30/2017	18:25	3361
Snow_cut_01__0_030_2017033019224	15	9	3/30/2017	19:31	3853.1
Snow_cut_01__0_034_2017033021163	16	9	3/30/2017	21:26	3206.1
Snow_cut_01__0_038_2017033022222	17	9	3/30/2017	22:32	1277.5
Snow_cut_01__0_042_2017033111105	18	9	3/31/2017	11:18	2167.9
Snow_cut_01__0_046_2017033112245	19	9	3/31/2017	12:32	-2542.3
Snow_cut_01__0_050_2017033114503	20	9	3/31/2017	14:58	-3113.1
Snow_cut_01__0_054_2017033115591	21	9	3/31/2017	16:12	-2544.6
Snow_cut_01__0_058_2017033117054	22	9	3/31/2017	17:12	-232.6
Snow_cut_0_010_2017032914124	2	10	3/29/2017	14:23	-134.2
Snow_cut_0_014_2017032915233	3	10	3/29/2017	15:33	-59
Snow_cut_0_019_2017032917012	4	10	3/29/2017	17:09	118.2
Snow_cut_0_023_2017032918005	5	10	3/29/2017	18:27	136.4
Snow_cut_0_027_2017032920090	6	10	3/29/2017	20:16	96.8
Snow_cut_0_031_2017032921214	7	10	3/29/2017	21:29	79.3
Snow_cut_0_035_2017032922314	8	10	3/29/2017	22:38	-77.4
Snow_cut_0_039_2017033011153	9	10	3/30/2017	11:28	-109.9
Snow_cut_01__0_003_2017033012500	10	10	3/30/2017	12:57	-79.4
Snow_cut_01__0_008_2017033014413	11	10	3/30/2017	14:49	-143.5
Snow_cut_01__0_014_2017033015563	12	10	3/30/2017	16:03	-77.6
Snow_cut_01__0_019_2017033016594	13	10	3/30/2017	17:07	98.1
Snow_cut_01__0_024_2017033018031	14	10	3/30/2017	18:12	93.8
Snow_cut_01__0_029_2017033019144	15	10	3/30/2017	19:21	114.9
Snow_cut_01__0_033_2017033021084	16	10	3/30/2017	21:15	100.1
Snow_cut_01__0_037_2017033022151	17	10	3/30/2017	22:21	42.9
Snow_cut_01__0_041_2017033110593	18	10	3/31/2017	11:09	67.7
Snow_cut_01__0_045_2017033112143	19	10	3/31/2017	12:23	-72.3
Snow_cut_01__0_049_2017033113130	20	10	3/31/2017	14:49	-111.2
Snow_cut_01__0_053_2017033115473	21	10	3/31/2017	15:57	-116.6
Snow_cut_01__0_057_2017033116571	22	10	3/31/2017	17:04	-49.4

Wilmington South of Port Transect Table

File Name	Round Number	Transect Number	Date	Start Time	Total Discharge (m^3/s)
WilHarb_0_031_2017032811250	1	4	3/29/2017	11:37	-707.3
WilHarb_0_034_2017032812185	2	4	3/29/2017	12:21	-1322.2
WilHarb_0_037_2017032812493	3	4	3/29/2017	13:06	-1559.5
WilHarb_0_040_2017032813362	4	4	3/29/2017	14:10	-1649.6
WilHarb_0_046_2017032915173	5	4	3/29/2017	15:33	-1390.2
WilHarb_0_049_2017032916024	6	4	3/29/2017	16:41	-175.7
WilHarb_0_055_2017032917475	7	4	3/29/2017	18:00	1380.9
WilHarb_0_058_2017032918280	8	4	3/29/2017	19:23	1688.5
WilHarb_0_061_2017032919521	9	4	3/29/2017	20:11	1709.8
WilHarb_0_064_2017032920360	10	4	3/29/2017	20:54	1684.5
WilHarb_0_068_2017032921321	11	4	3/29/2017	21:57	1409.9
WilHarb_0_077_2017033011314	12	4	3/30/2017	11:43	479.3
WilHarb_0_080_2017033012091	13	4	3/30/2017	12:25	-821.2
WilHarb_0_083_2017033012540	14	4	3/30/2017	13:08	-1403.6
WilHarb_0_089_2017033014372	15	4	3/30/2017	14:52	-1720.4
WilHarb_0_092_2017033015195	16	4	3/30/2017	15:33	-1748.2
WilHarb_0_095_2017033016021	17	4	3/30/2017	16:16	-1457.5
WilHarb_0_101_2017033017155	18	4	3/30/2017	17:33	-101.2
WilHarb_0_104_2017033017564	19	4	3/30/2017	18:14	830.1
WilHarb_0_107_2017033018375	20	4	3/30/2017	18:56	1459.3
WilHarb_0_110_2017033019200	21	4	3/30/2017	19:36	1764.8
WilHarb_0_116_2017033021010	22	4	3/30/2017	21:16	1686.3
WilHarb_0_119_2017033021393	23	4	3/30/2017	21:57	1658.6
WilHarb_0_032_2017032811395	1	5	3/29/2017	11:47	-595.9
WilHarb_0_035_2017032812240	2	5	3/29/2017	12:31	-564.2
WilHarb_0_038_2017032813104	3	5	3/29/2017	13:18	-529.6
WilHarb_0_041_2017032914144	4	5	3/29/2017	14:21	-551.9
WilHarb_0_047_2017032915382	5	5	3/29/2017	15:45	-287
WilHarb_0_050_2017032916450	6	5	3/29/2017	16:54	503.8
WilHarb_0_056_2017032918031	7	5	3/29/2017	18:11	659.3
WilHarb_0_059_2017032919263	8	5	3/29/2017	19:36	570.1
WilHarb_0_062_2017032920132	9	5	3/29/2017	20:22	499.8
WilHarb_0_065_2017032920571	10	5	3/29/2017	21:07	453.1
WilHarb_0_069_2017032921595	11	5	3/29/2017	22:08	344.2
WilHarb_0_078_2017033011454	12	5	3/30/2017	11:53	-229.3
WilHarb_0_081_2017033012283	13	5	3/30/2017	12:36	-652.4
WilHarb_0_084_2017033013112	14	5	3/30/2017	13:18	-646
WilHarb_0_090_2017033014554	15	5	3/30/2017	15:03	-563.2
WilHarb_0_093_2017033015364	16	5	3/30/2017	15:45	-535.4
WilHarb_0_096_2017033016192	17	5	3/30/2017	16:26	-377.6
WilHarb_0_102_2017033017363	18	5	3/30/2017	17:43	607.4
WilHarb_0_105_2017033018162	19	5	3/30/2017	18:23	728.4
WilHarb_0_108_2017033018590	20	5	3/30/2017	19:06	703.4
WilHarb_0_111_2017033019390	21	5	3/30/2017	19:47	684.8
WilHarb_0_117_2017033021194	22	5	3/30/2017	21:27	522.9
WilHarb_0_120_2017033021591	23	5	3/30/2017	22:06	470.1
WilHarb_0_033_2017032811515	1	6	3/29/2017	11:59	-1842.4
WilHarb_0_036_2017032812373	2	6	3/29/2017	12:42	-2214.7
WilHarb_0_039_2017032813194	3	6	3/29/2017	13:30	-2277
WilHarb_0_042_2017032914232	4	6	3/29/2017	14:33	-2270.8
WilHarb_0_048_2017032915472	5	6	3/29/2017	15:56	-1281.1
WilHarb_0_051_2017032916562	6	6	3/29/2017	17:04	1159.1

Wilmington South of Port Transect Table					
File Name	Round Number	Transect Number	Date	Start Time	Total Discharge (m^3/s)
WilHarb_0_057_2017032918124	7	6	3/29/2017	18:21	2413.7
WilHarb_0_060_2017032919374	8	6	3/29/2017	19:46	2357.9
WilHarb_0_063_2017032920240	9	6	3/29/2017	20:31	2276.3
WilHarb_0_067_2017032921234	10	6	3/29/2017	21:27	1950
WilHarb_0_070_2017032922094	11	6	3/29/2017	22:19	1449.1
WilHarb_0_079_2017033011543	12	6	3/30/2017	12:04	-730.1
WilHarb_0_082_2017033012371	13	6	3/30/2017	12:48	-2039.9
WilHarb_0_085_2017033013194	14	6	3/30/2017	13:29	-2320.4
WilHarb_0_091_2017033015041	15	6	3/30/2017	15:14	-2391.8
WilHarb_0_094_2017033015461	16	6	3/30/2017	15:56	-2173.9
WilHarb_0_097_2017033016280	17	6	3/30/2017	16:38	-1423
WilHarb_0_103_2017033017450	18	6	3/30/2017	17:52	1178
WilHarb_0_106_2017033018241	19	6	3/30/2017	18:32	2114.3
WilHarb_0_109_2017033019074	20	6	3/30/2017	19:14	2382
WilHarb_0_112_2017033019491	21	6	3/30/2017	19:56	2412.7
WilHarb_0_118_2017033021283	22	6	3/30/2017	21:35	2247.7
WilHarb_0_121_2017033022080	23	6	3/30/2017	22:15	2025.8

Wilmington Downtown Transect Table

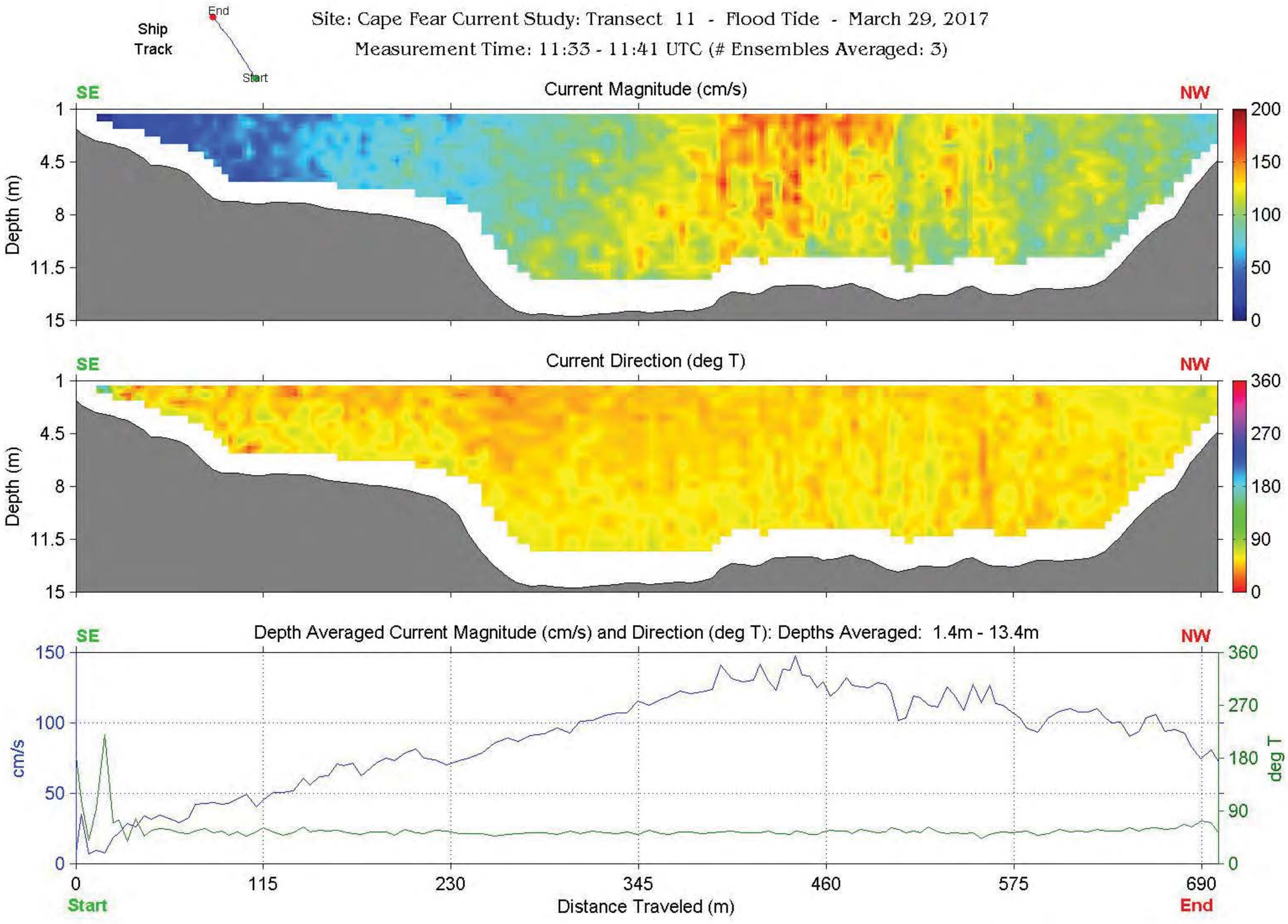
File Name	Round Number	Transect Number	Date	Start Time	Total Discharge (m^3/s)
WilHarb_0_028_2017032810562	1	1	3/29/2017	11:13	-196.3
WilHarb_0_043_2017032914392	2	1	3/29/2017	15:03	-976.1
WilHarb_0_052_2017032917112	3	1	3/29/2017	17:35	526.3
WilHarb_0_071_2017032922233	4	1	3/29/2017	23:07	278.2
WilHarb_0_074_2017033011151	5	1	3/30/2017	11:16	728.2
WilHarb_0_086_2017033013361	6	1	3/30/2017	14:25	-1017.6
WilHarb_0_098_2017033016441	7	1	3/30/2017	17:04	-686.8
WilHarb_0_113_2017033020031	8	1	3/30/2017	20:50	1004.7
WilHarb_0_123_2017033022405	9	1	3/30/2017	22:48	808.4
WilHarb_0_126_2017033022590	10	1	3/30/2017	23:04	773.8
WilHarb_0_129_2017033023143	11	1	3/31/2017	11:14	937.4
WilHarb_0_132_2017033111261	12	1	3/31/2017	11:38	849.8
WilHarb_0_135_2017033111492	13	1	3/31/2017	11:57	733.3
WilHarb_0_138_2017033112075	14	1	3/31/2017	12:16	634.2
WilHarb_0_142_2017033113184	15	1	3/31/2017	14:40	-977.9
WilHarb_0_145_2017033114534	16	1	3/31/2017	15:02	-943.3
WilHarb_0_148_2017033115175	17	1	3/31/2017	15:28	-1094.5
WilHarb_0_151_2017033115414	18	1	3/31/2017	15:51	-1018.8
WilHarb_0_154_2017033116070	19	1	3/31/2017	16:15	-1041.3
WilHarb_0_157_2017033116281	20	1	3/31/2017	16:37	-1015.5
WilHarb_0_160_2017033116541	21	1	3/31/2017	17:04	-961
WilHarb_0_164_2017033117283	22	1	3/31/2017	17:29	-829.9
WilHarb_0_029_2017032811145	1	2	3/29/2017	11:18	2.1
WilHarb_0_044_2017032915051	2	2	3/29/2017	15:09	-529.7
WilHarb_0_053_2017032917374	3	2	3/29/2017	17:41	404.2
WilHarb_0_072_2017032923100	4	2	3/29/2017	23:13	68.5
WilHarb_0_075_2017033011180	5	2	3/30/2017	11:22	310.9
WilHarb_0_087_2017033014270	6	2	3/30/2017	14:31	-506.7
WilHarb_0_099_2017033017054	7	2	3/30/2017	17:09	-189.7
WilHarb_0_114_2017033020522	8	2	3/30/2017	20:55	437.4
WilHarb_0_124_2017033022501	9	2	3/30/2017	22:53	696.6
WilHarb_0_127_2017033023054	10	2	3/30/2017	23:08	329.9
WilHarb_0_130_2017033111161	11	2	3/31/2017	11:19	470.7
WilHarb_0_133_2017033111403	12	2	3/31/2017	11:44	393.2
WilHarb_0_136_2017033111585	13	2	3/31/2017	12:01	335.8
WilHarb_0_139_2017033112173	14	2	3/31/2017	12:20	277.4
WilHarb_0_143_2017033114420	15	2	3/31/2017	14:46	-517.2
WilHarb_0_146_2017033115043	16	2	3/31/2017	15:08	-544.4
WilHarb_0_149_2017033115301	17	2	3/31/2017	15:34	-497.2
WilHarb_0_152_2017033115531	18	2	3/31/2017	15:58	-579.1
WilHarb_0_155_2017033116174	19	2	3/31/2017	16:21	-487.7
WilHarb_0_158_2017033116402	20	2	3/31/2017	16:44	-404.5
WilHarb_0_161_2017033117065	21	2	3/31/2017	17:12	-481.9
WilHarb_0_165_2017033117314	22	2	3/31/2017	17:35	-322.4
WilHarb_0_030_2017032811193	1	3	3/29/2017	11:23	-10.5
WilHarb_0_045_2017032915103	2	3	3/29/2017	15:15	-1462.4
WilHarb_0_054_2017032917420	3	3	3/29/2017	17:46	981.9
WilHarb_0_073_2017032923144	4	3	3/29/2017	23:19	50.1
WilHarb_0_076_2017033011231	5	3	3/30/2017	11:28	787
WilHarb_0_088_2017033014314	6	3	3/30/2017	14:36	-1574.2
WilHarb_0_100_2017033017101	7	3	3/30/2017	17:14	-719.2

Wilmington Downtown Transect Table					
File Name	**Round Number**	**Transect Number**	**Date**	**Start Time**	**Total Discharge (m^3/s)**
WilHarb_0_115_2017033020561	8	3	3/30/2017	20:59	1481.4
WilHarb_0_125_2017033022541	9	3	3/30/2017	22:57	1098.2
WilHarb_0_128_2017033023093	10	3	3/30/2017	23:13	973.1
WilHarb_0_131_2017033111203	11	3	3/31/2017	11:24	1365.4
WilHarb_0_134_2017033111444	12	3	3/31/2017	11:48	1144.4
WilHarb_0_137_2017033112023	13	3	3/31/2017	12:06	923.3
WilHarb_0_140_2017033112212	14	3	3/31/2017	12:25	834.9
WilHarb_0_144_2017033114471	15	3	3/31/2017	14:52	-1535.4
WilHarb_0_147_2017033115092	16	3	3/31/2017	15:15	-1620.3
WilHarb_0_150_2017033115351	17	3	3/31/2017	15:40	-1627
WilHarb_0_153_2017033115584	18	3	3/31/2017	16:05	-1615.4
WilHarb_0_156_2017033116215	19	3	3/31/2017	16:27	-1643.4
WilHarb_0_159_2017033116452	20	3	3/31/2017	16:53	-1521.6
WilHarb_0_162_2017033117131	21	3	3/31/2017	17:19	-1301
WilHarb_0_166_2017033117361	22	3	3/31/2017	17:49	-742.1

Southport

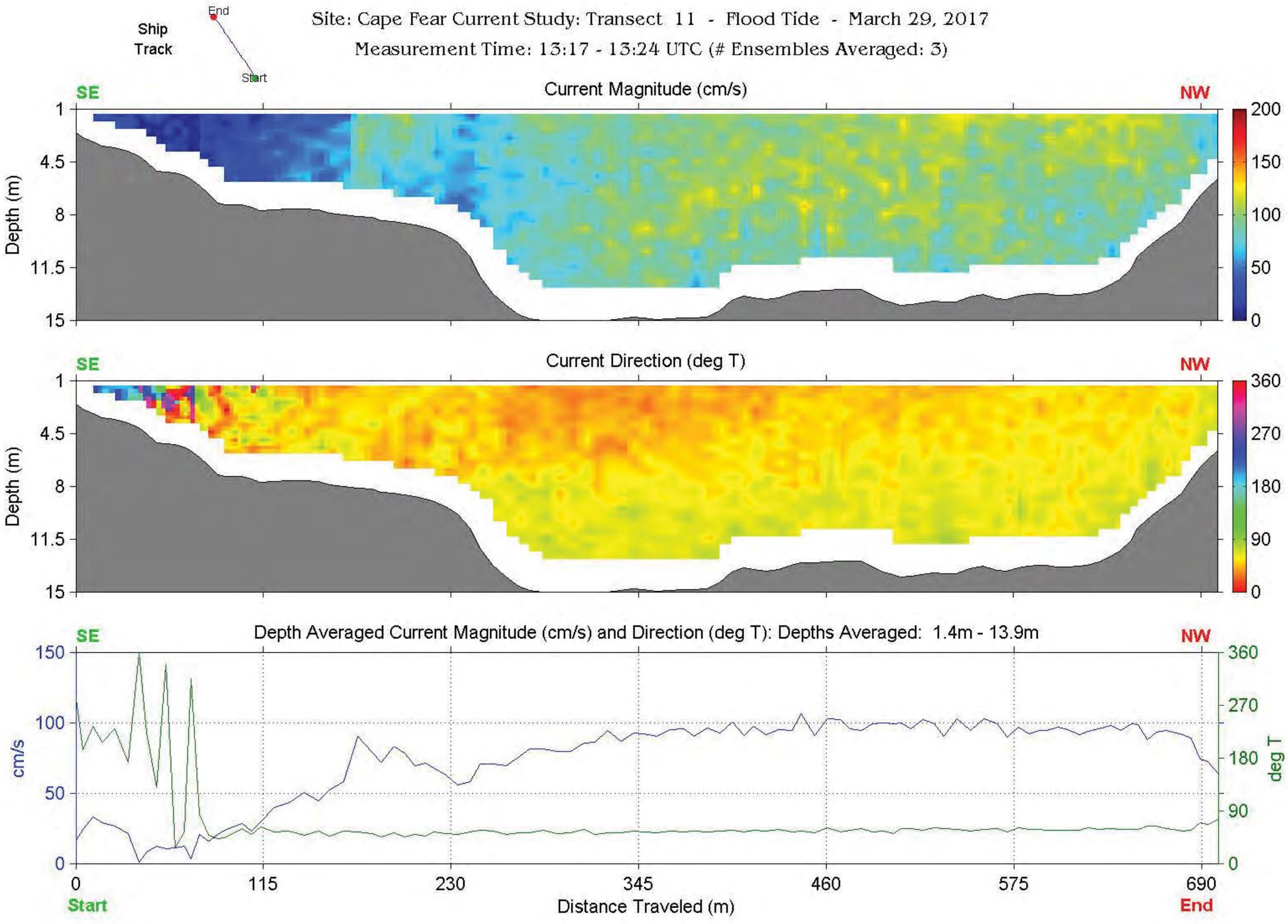
Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 29, 2017

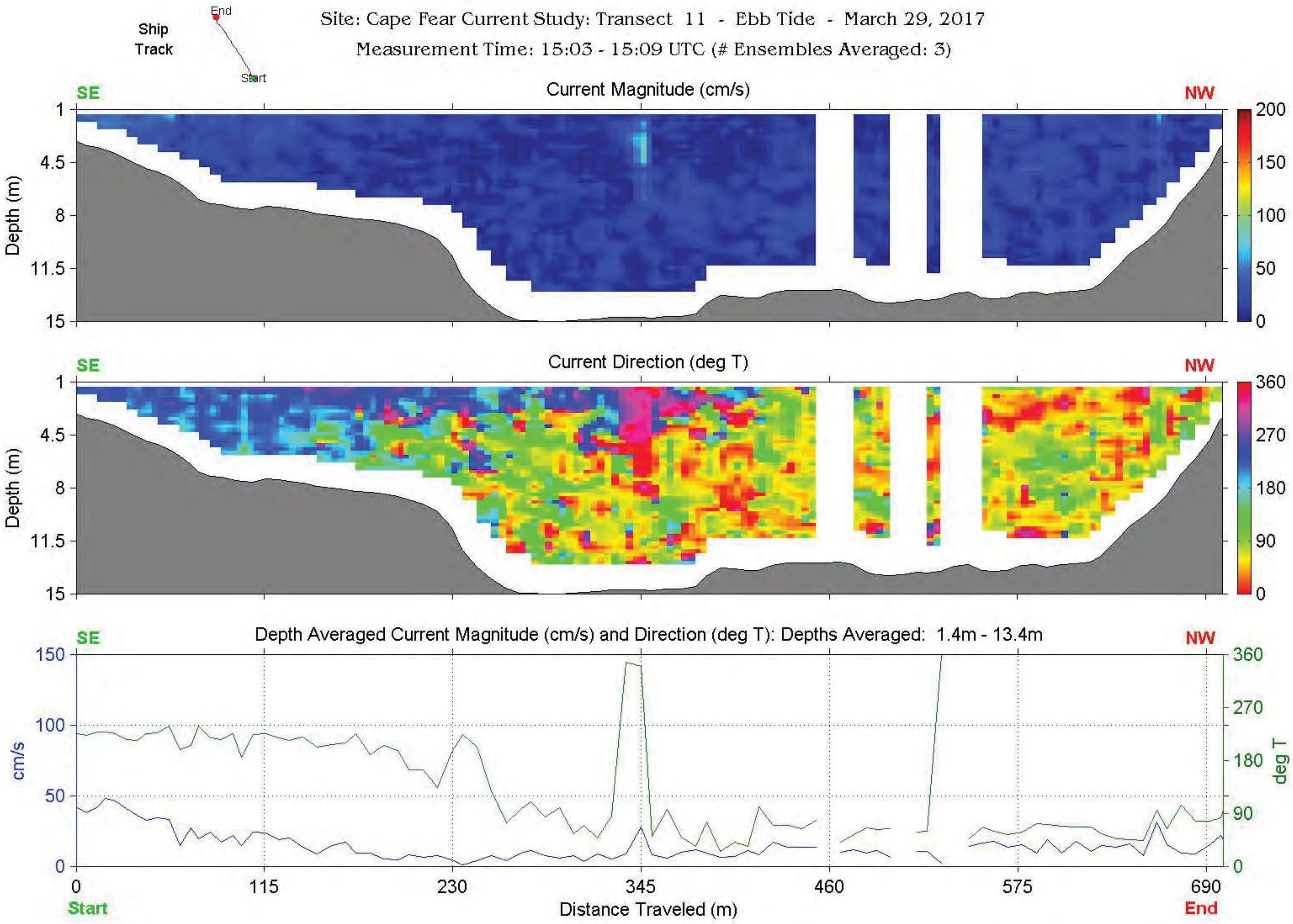
Measurement Time: 11:33 - 11:41 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 29, 2017

Measurement Time: 13:17 - 13:24 UTC (# Ensembles Averaged: 3)



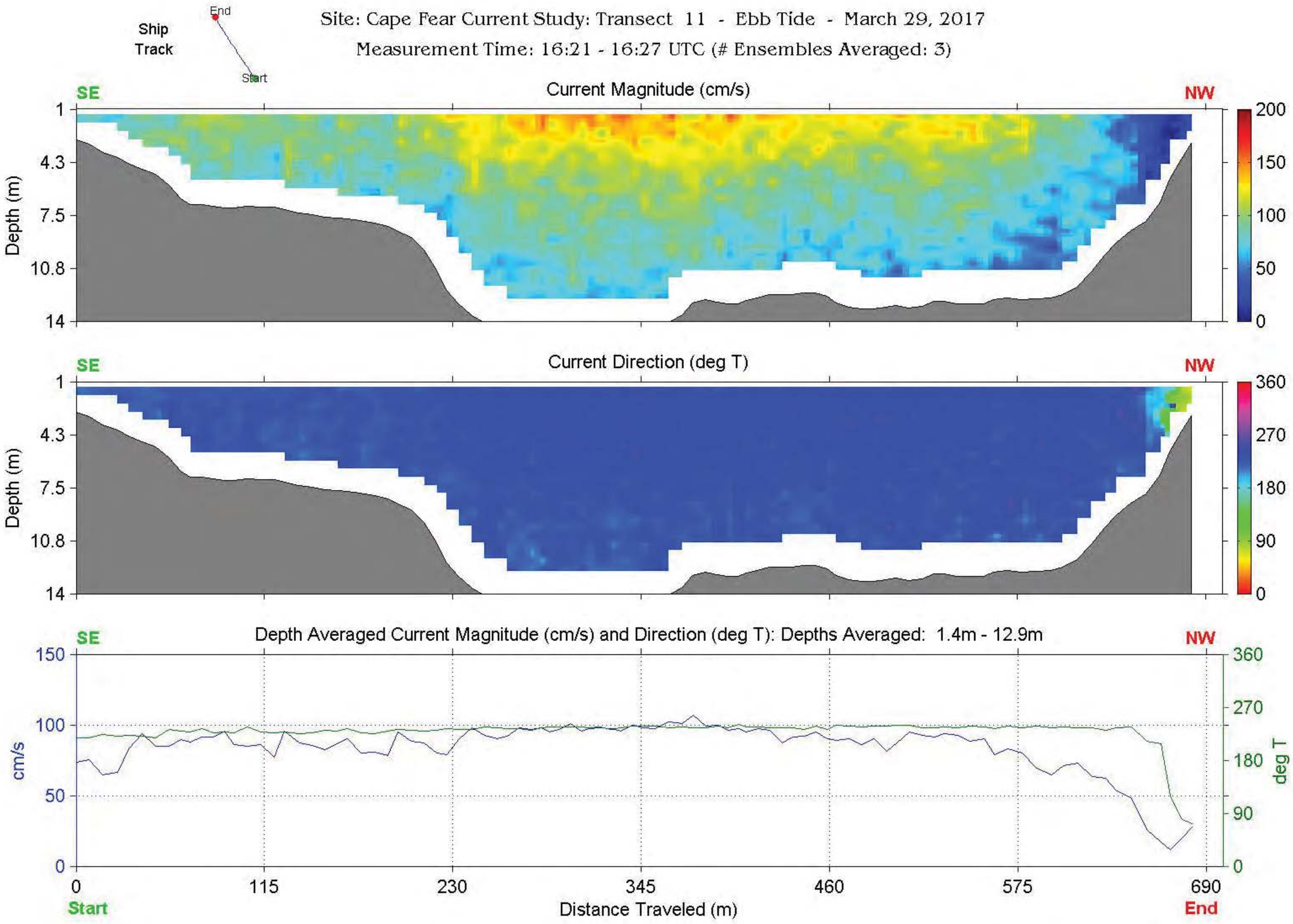


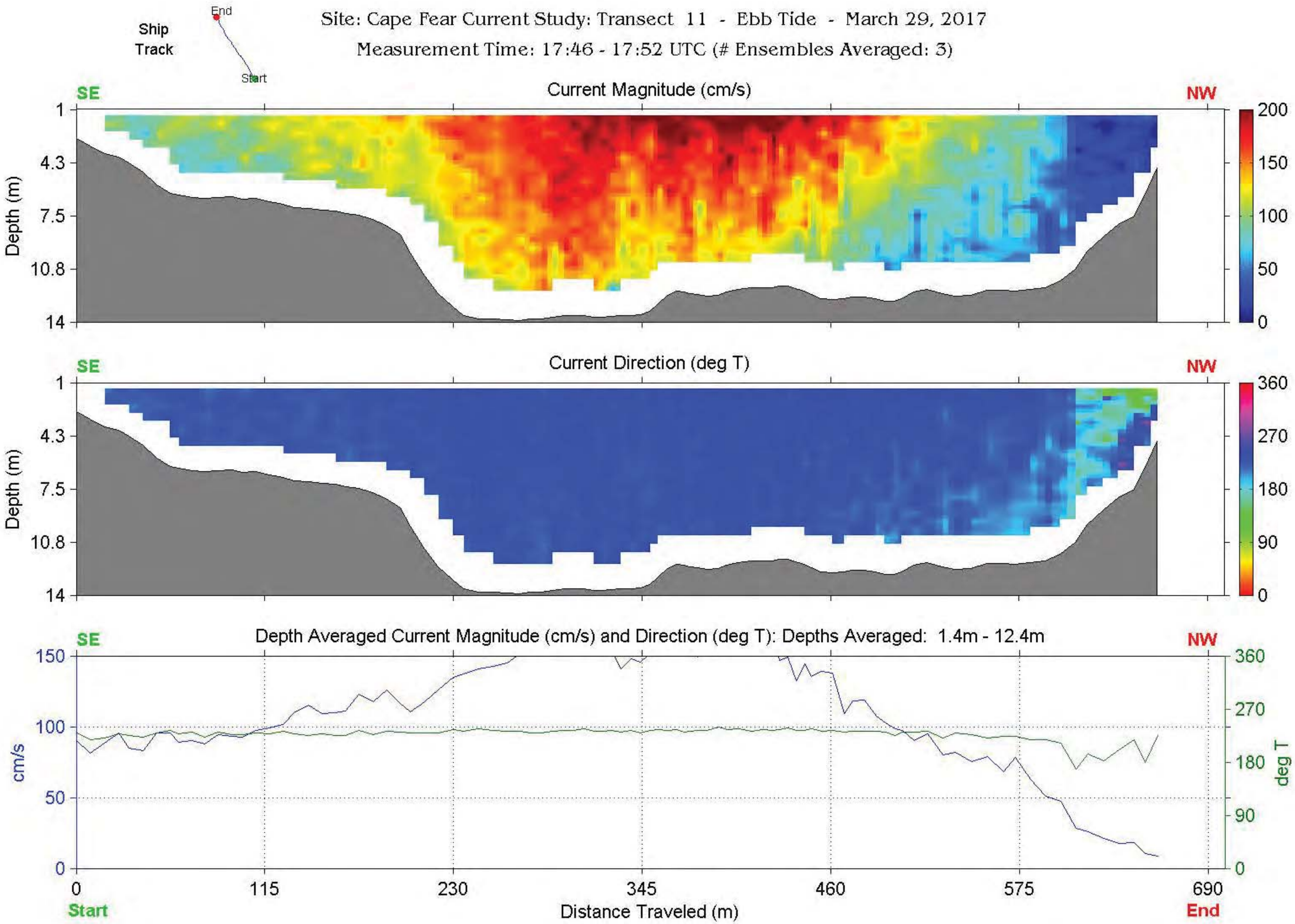
Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 29, 2017

Measurement Time: 15:03 - 15:09 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 29, 2017

Measurement Time: 16:21 - 16:27 UTC (# Ensembles Averaged: 3)

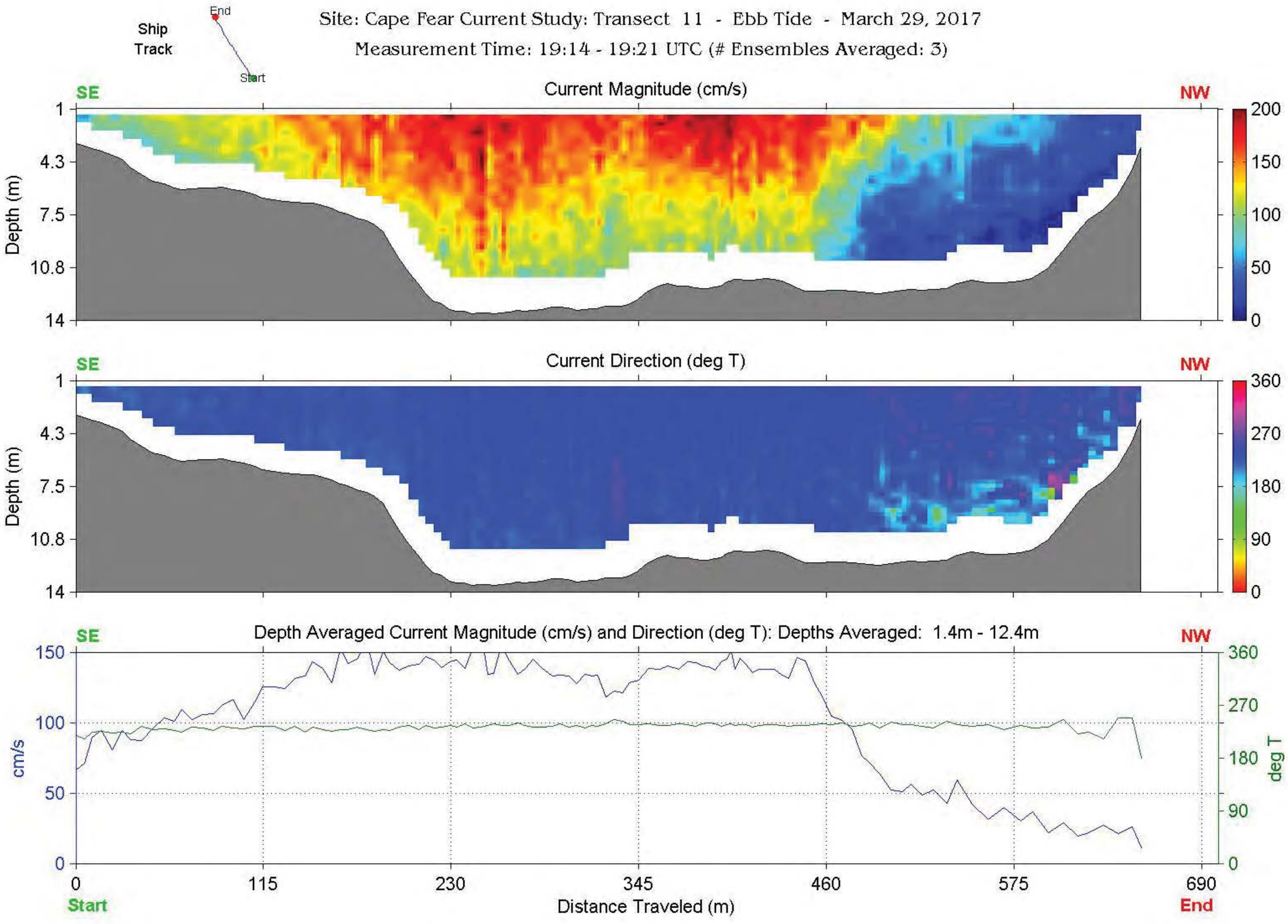


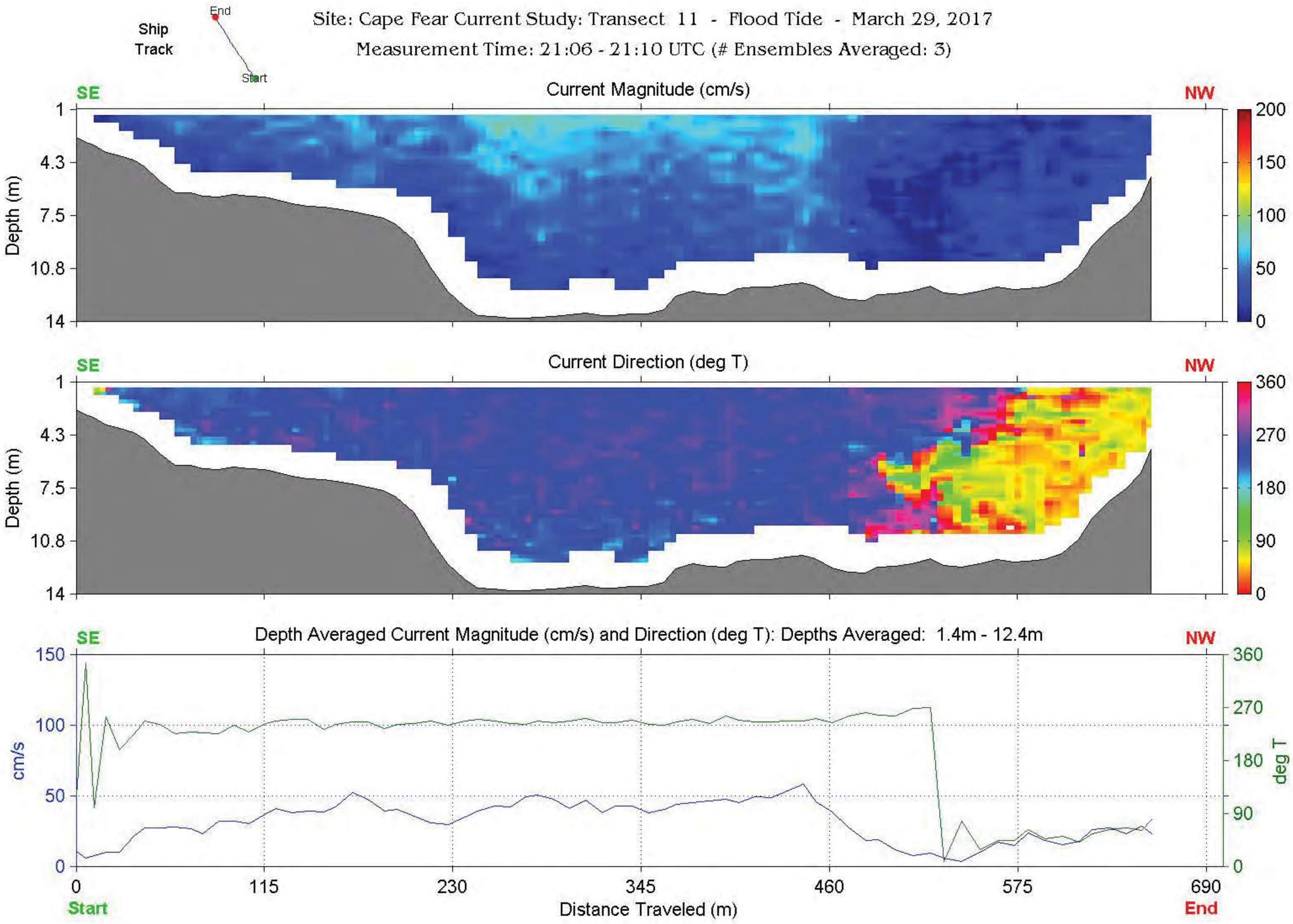

Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 29, 2017

Measurement Time: 17:46 - 17:52 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 29, 2017

Measurement Time: 19:14 - 19:21 UTC (# Ensembles Averaged: 3)

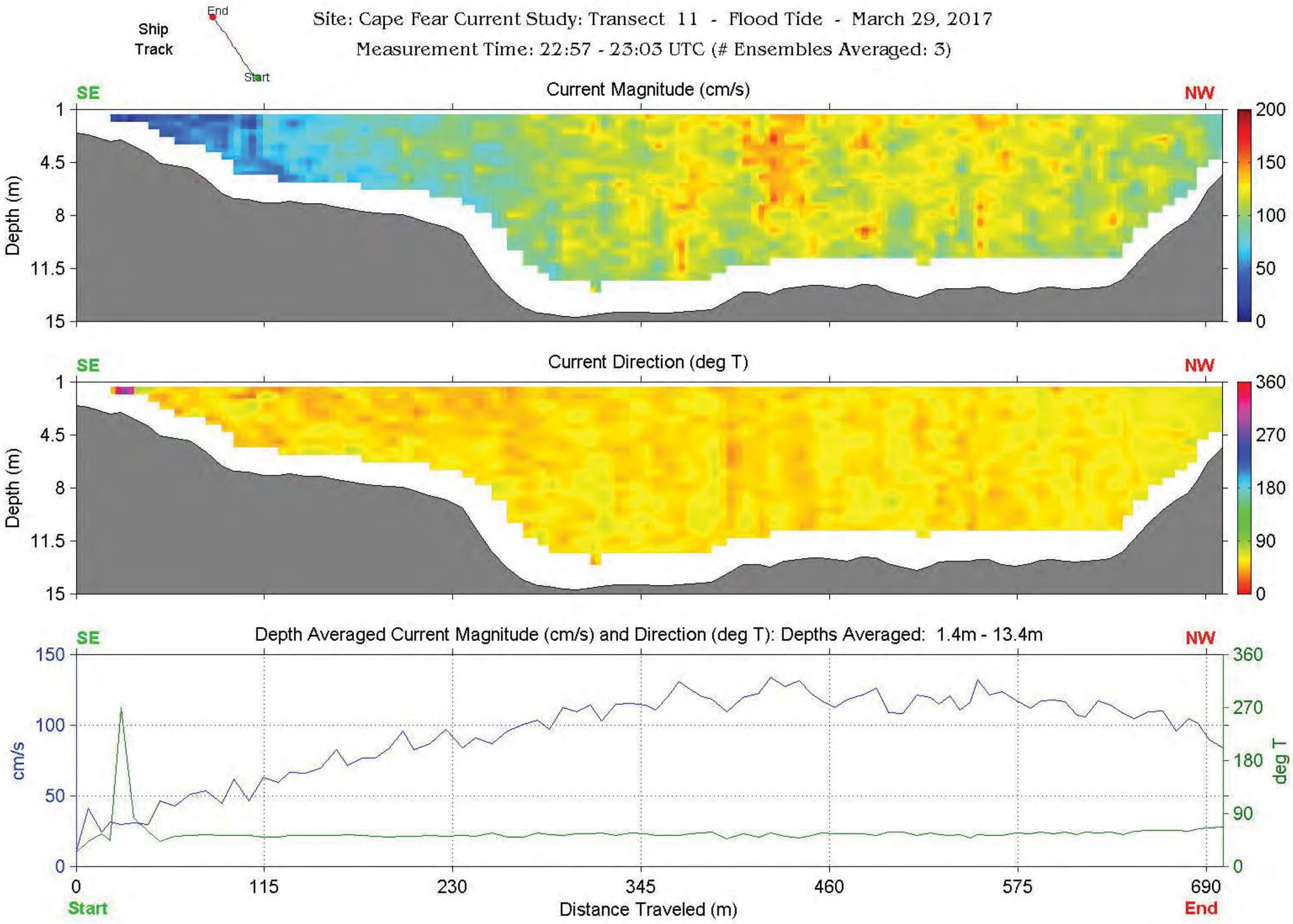



Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 29, 2017

Measurement Time: 21:06 - 21:10 UTC (# Ensembles Averaged: 3)

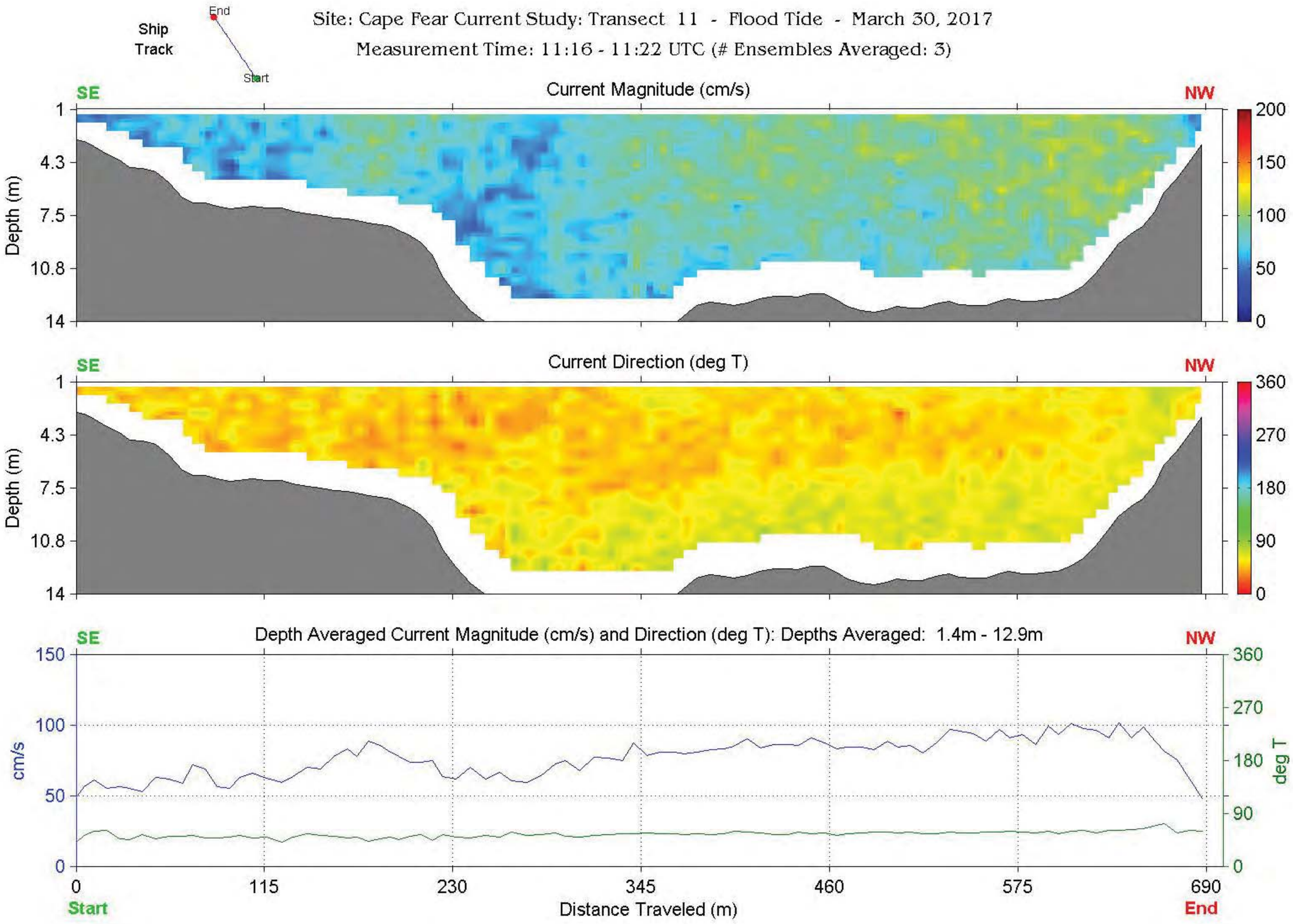
Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 29, 2017

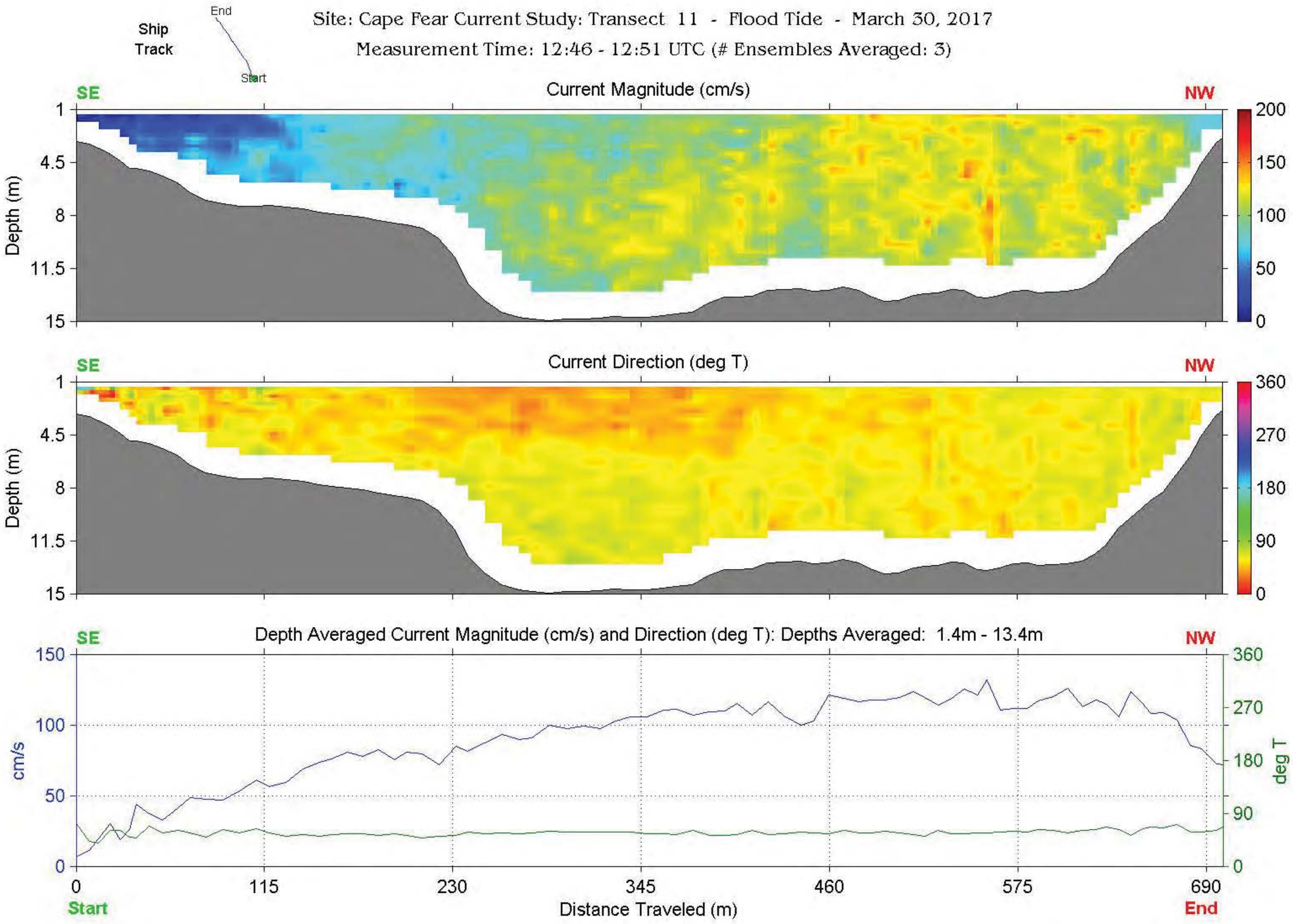
Measurement Time: 22:57 - 23:03 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 30, 2017

Measurement Time: 11:16 - 11:22 UTC (# Ensembles Averaged: 3)



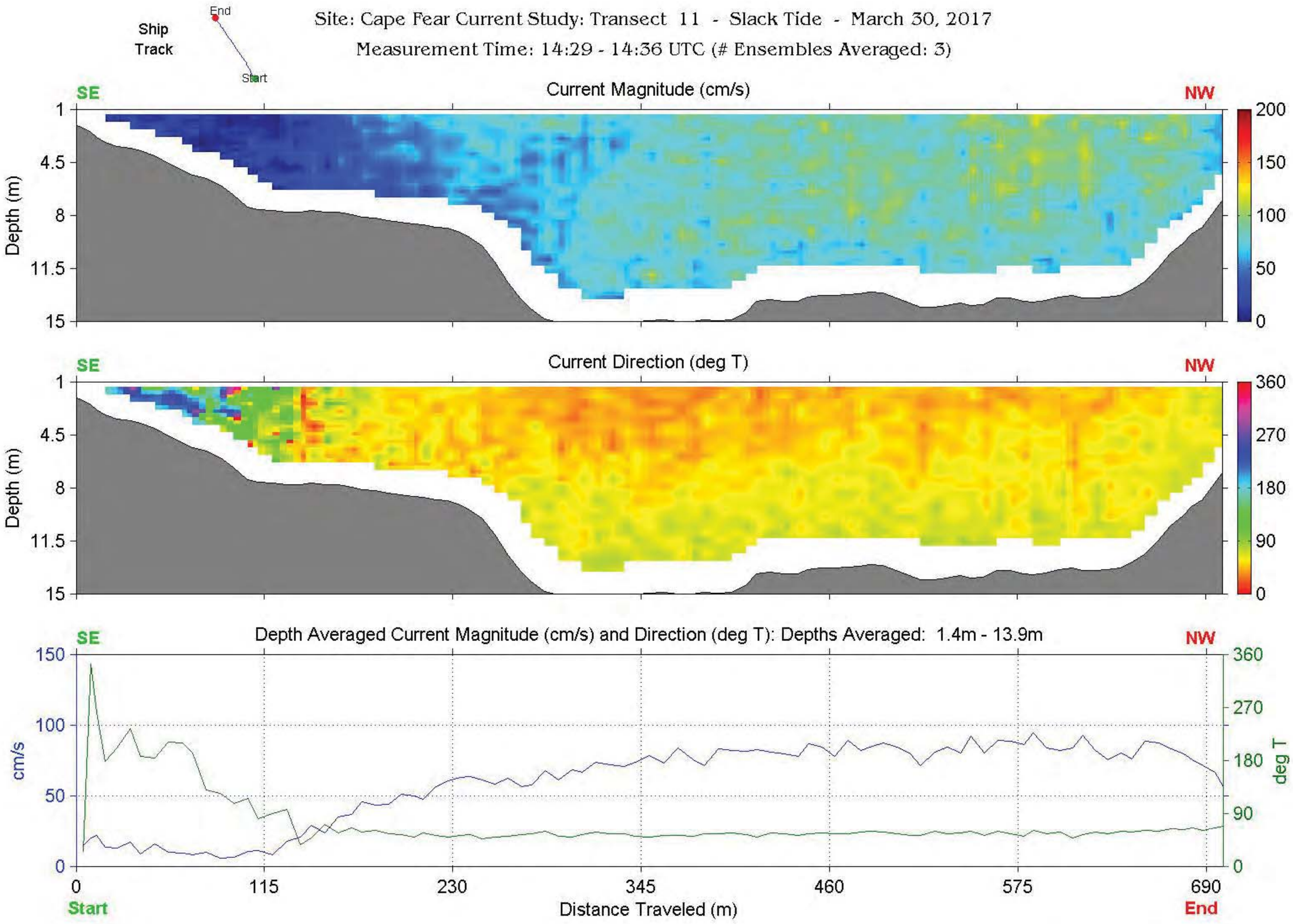


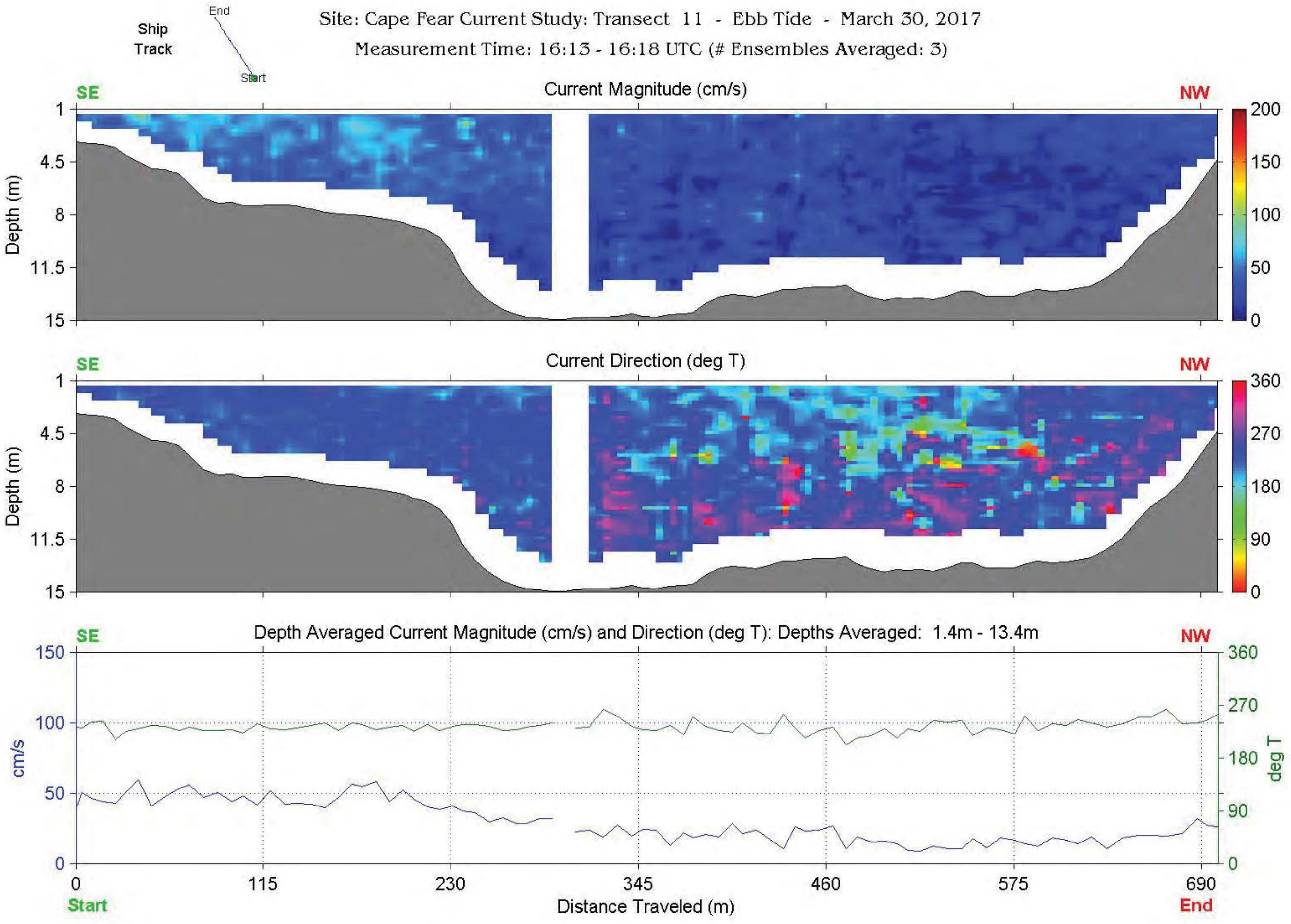
Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 30, 2017

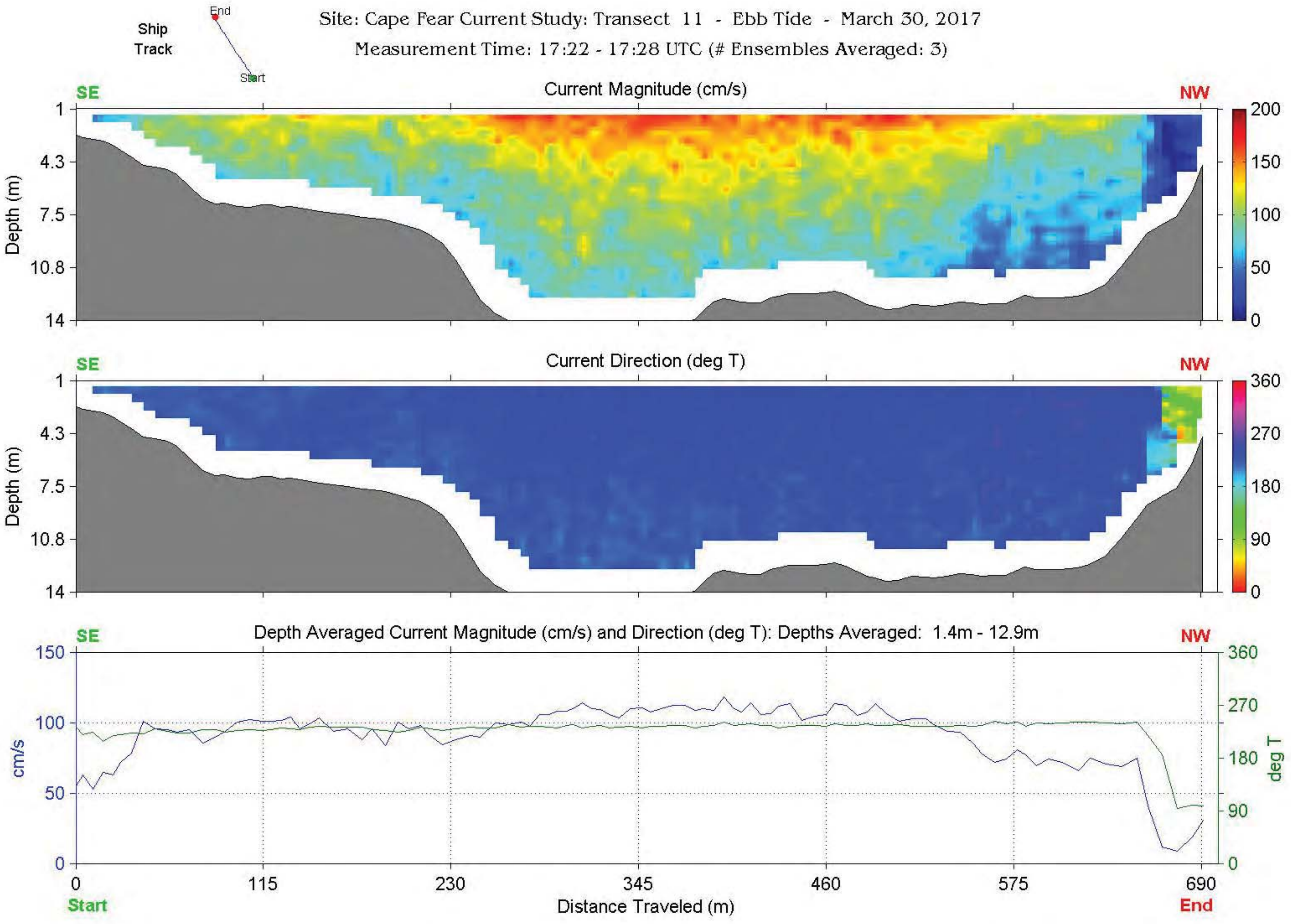
Measurement Time: 12:46 - 12:51 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 11 - Slack Tide - March 30, 2017

Measurement Time: 14:29 - 14:36 UTC (# Ensembles Averaged: 3)

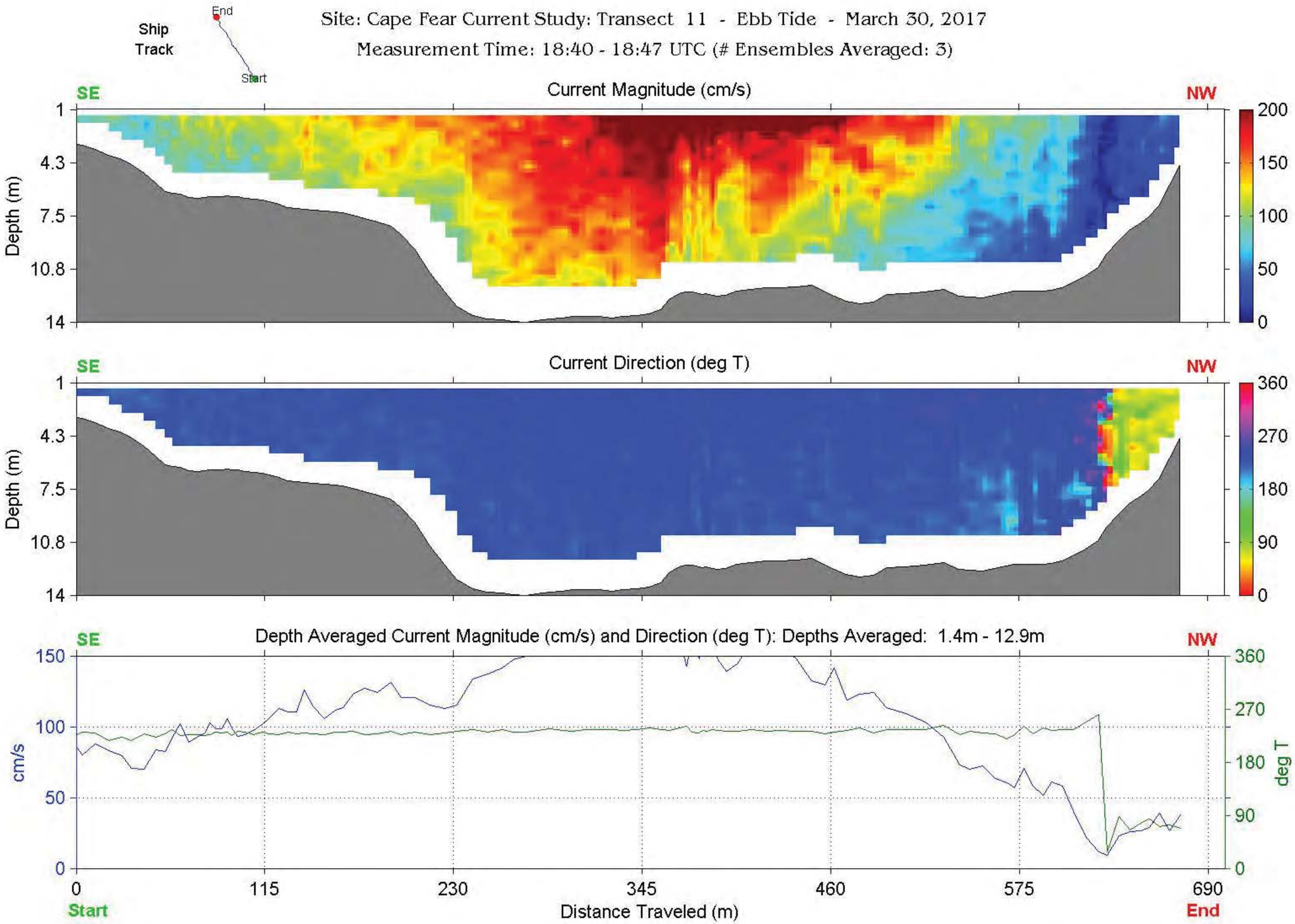



Ship
Track
End
Start
Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 30, 2017
Measurement Time: 16:13 - 16:18 UTC (# Ensembles Averaged: 3)
SE
Current Magnitude (cm/s)
NW
Depth (m)
1
4.5
8
11.5
15
200
150
100
50
0
SE
Current Direction (deg T)
NW
Depth (m)
1
4.5
8
11.5
15
360
270
180
90
0
SE
Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.4m - 13.4m
NW
cm/s
150
100
50
0
deg T
360
270
180
90
0
0
115
230
345
460
575
690
Start
Distance Traveled (m)
End



Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 30, 2017

Measurement Time: 17:22 - 17:28 UTC (# Ensembles Averaged: 3)

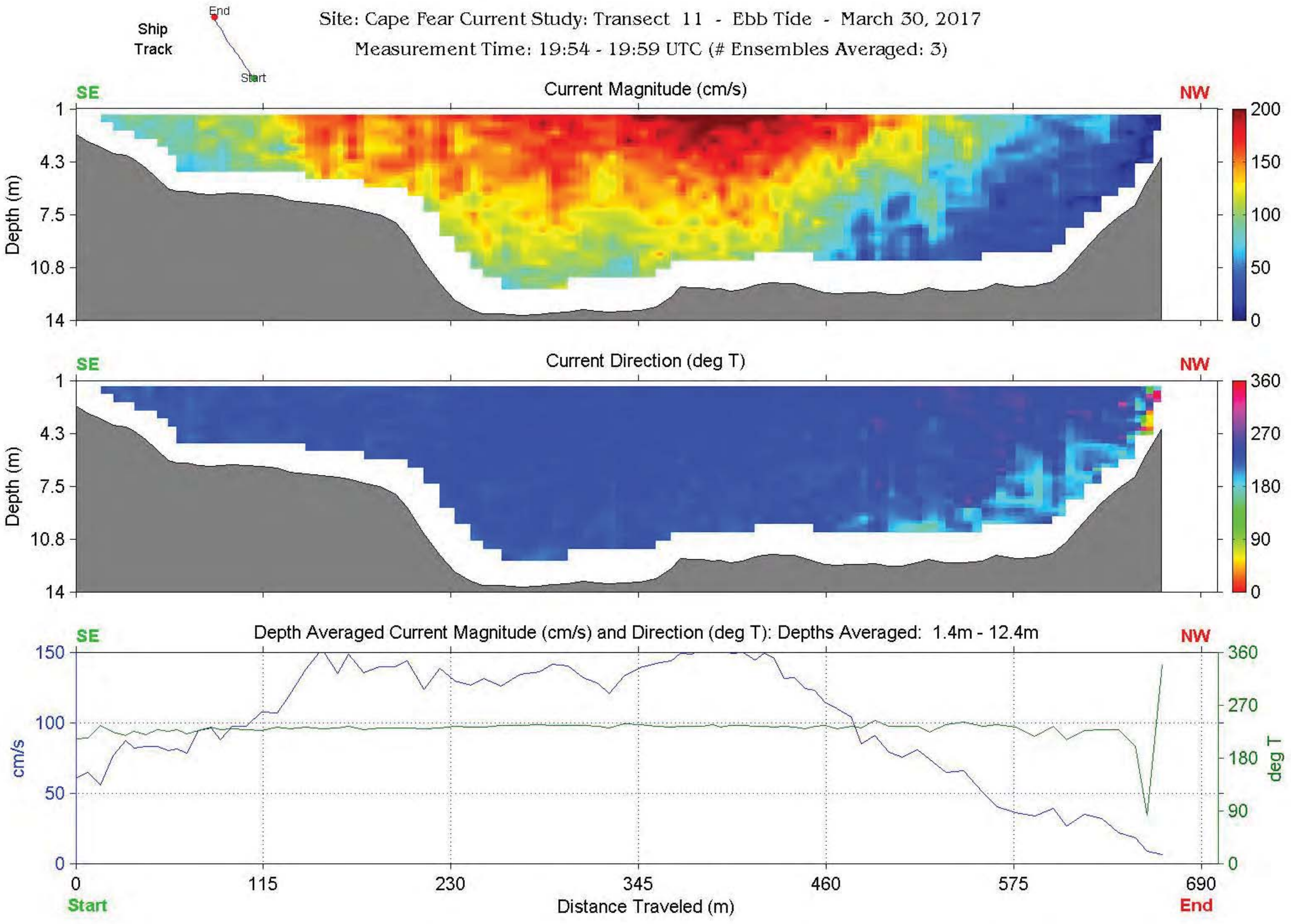


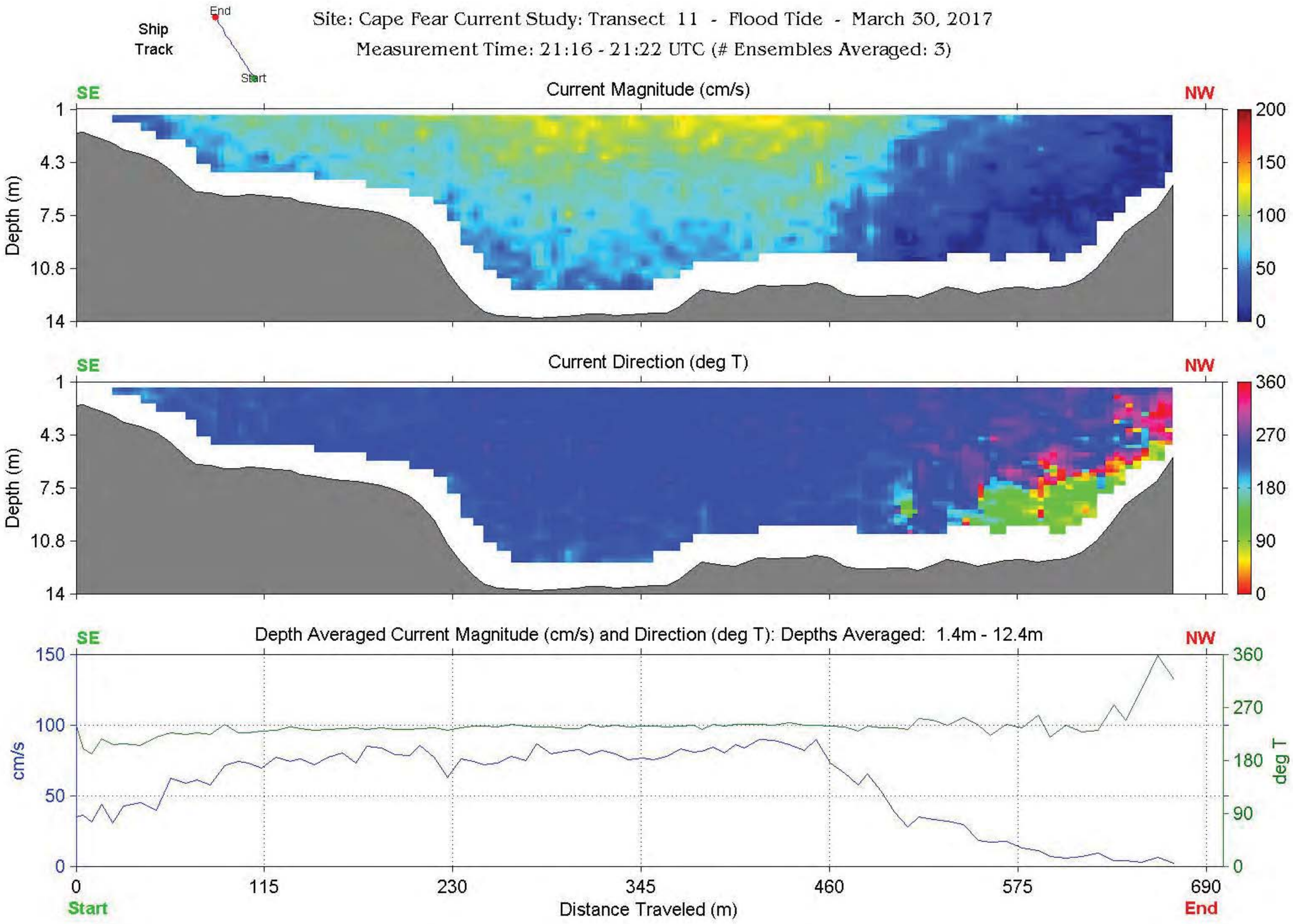
Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 30, 2017

Measurement Time: 18:40 - 18:47 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 11 - Ebb Tide - March 30, 2017

Measurement Time: 19:54 - 19:59 UTC (# Ensembles Averaged: 3)



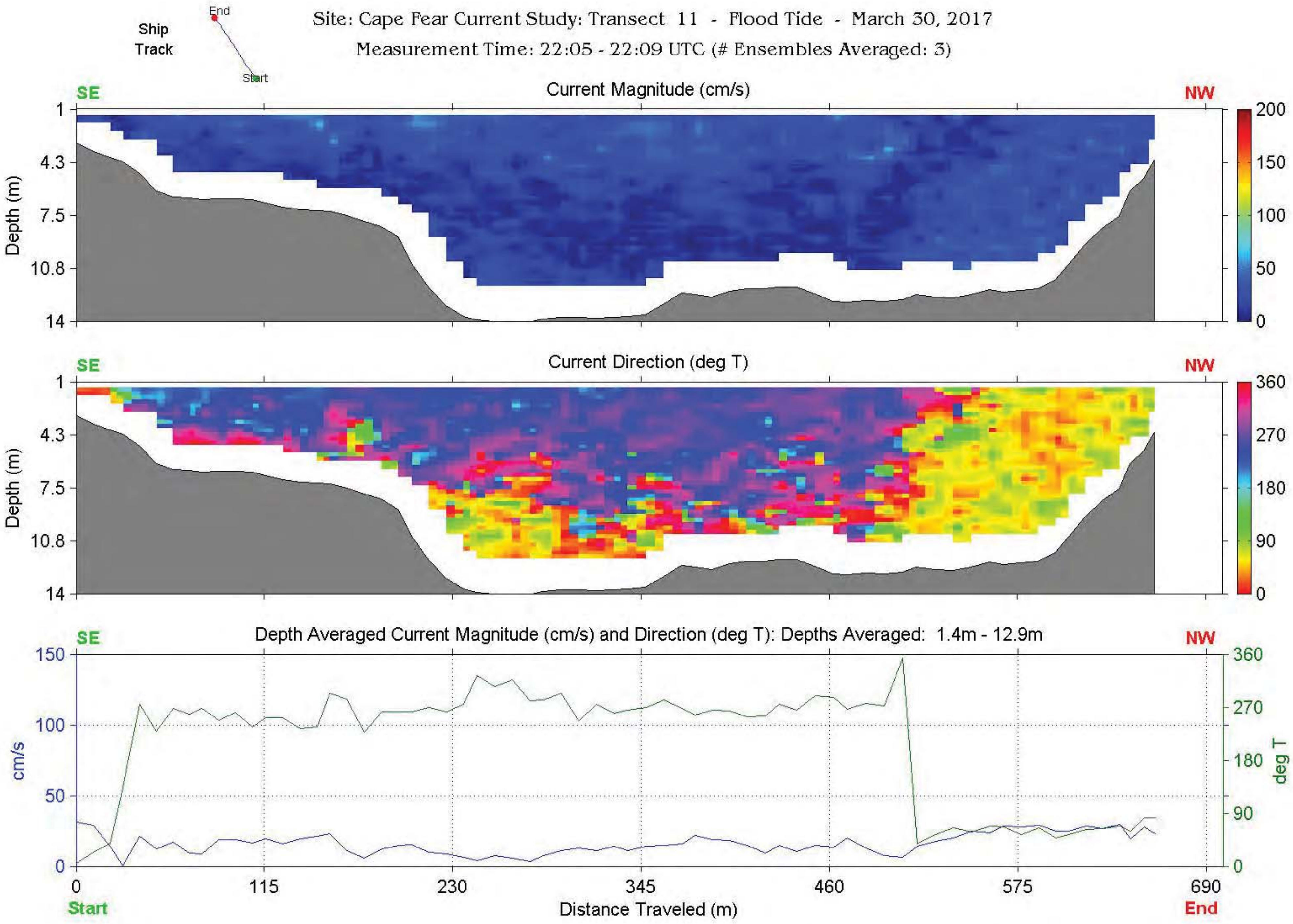


Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 30, 2017

Measurement Time: 21:16 - 21:22 UTC (# Ensembles Averaged: 3)

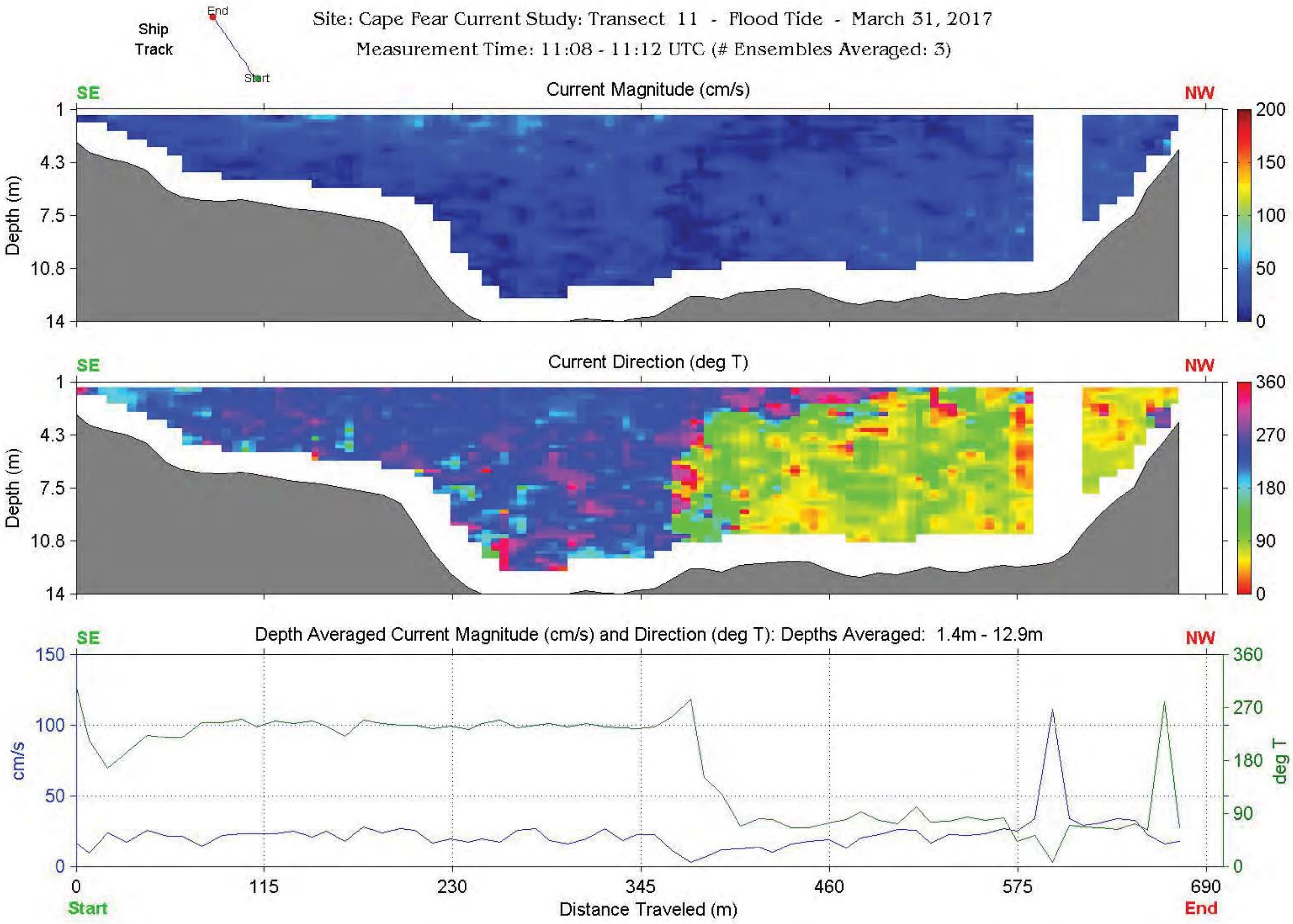
Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 30, 2017

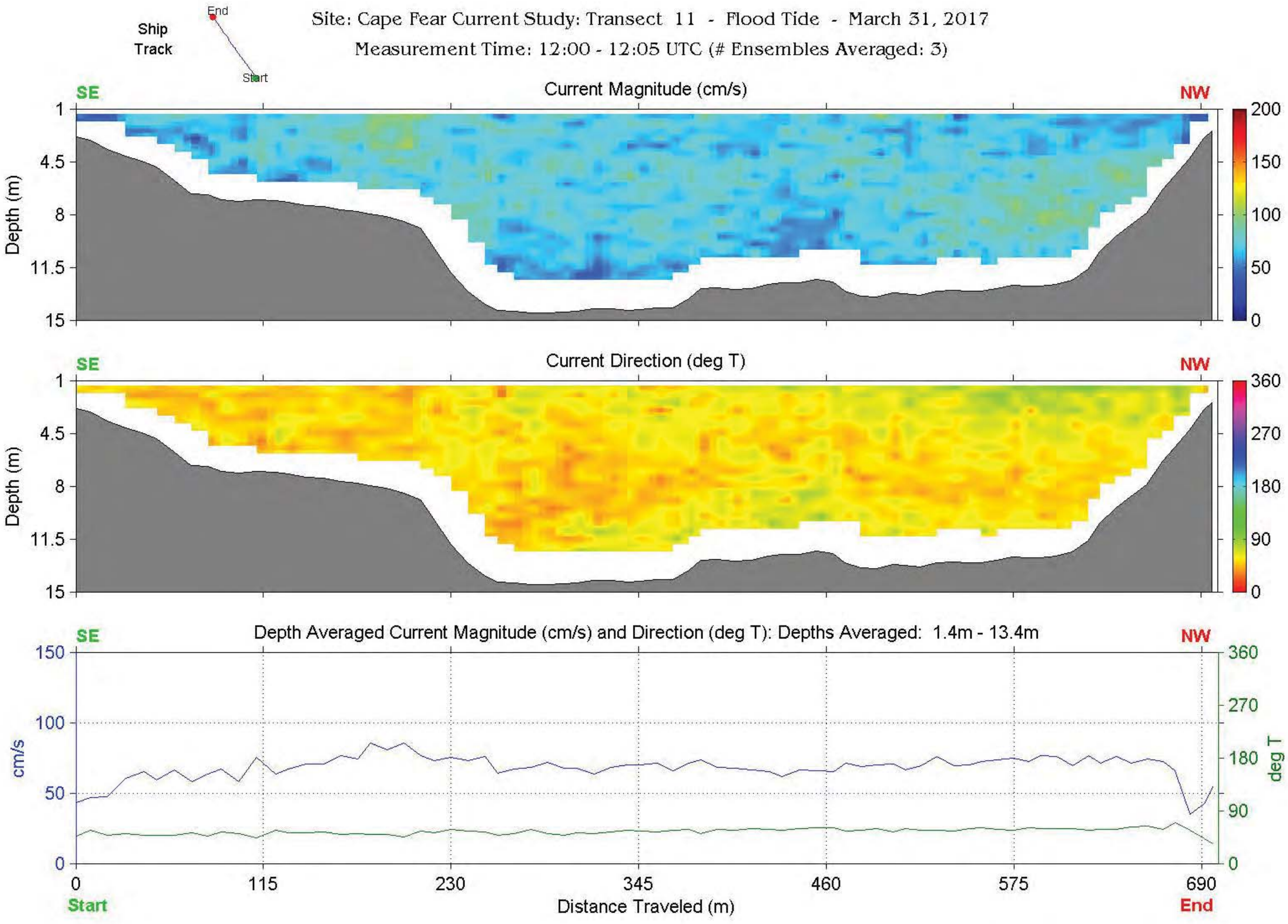
Measurement Time: 22:05 - 22:09 UTC (# Ensembles Averaged: 3)



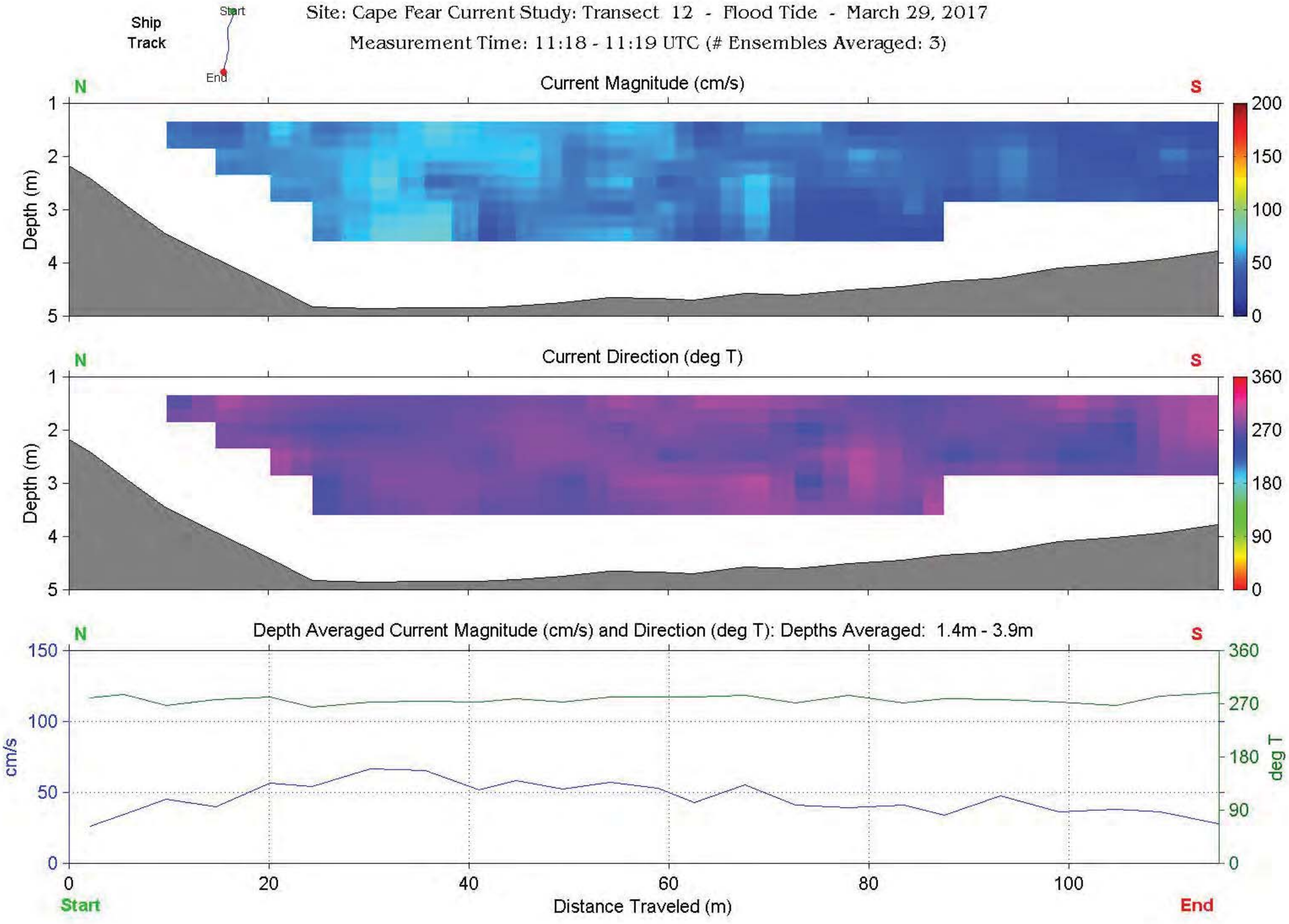
Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 31, 2017

Measurement Time: 11:08 - 11:12 UTC (# Ensembles Averaged: 3)

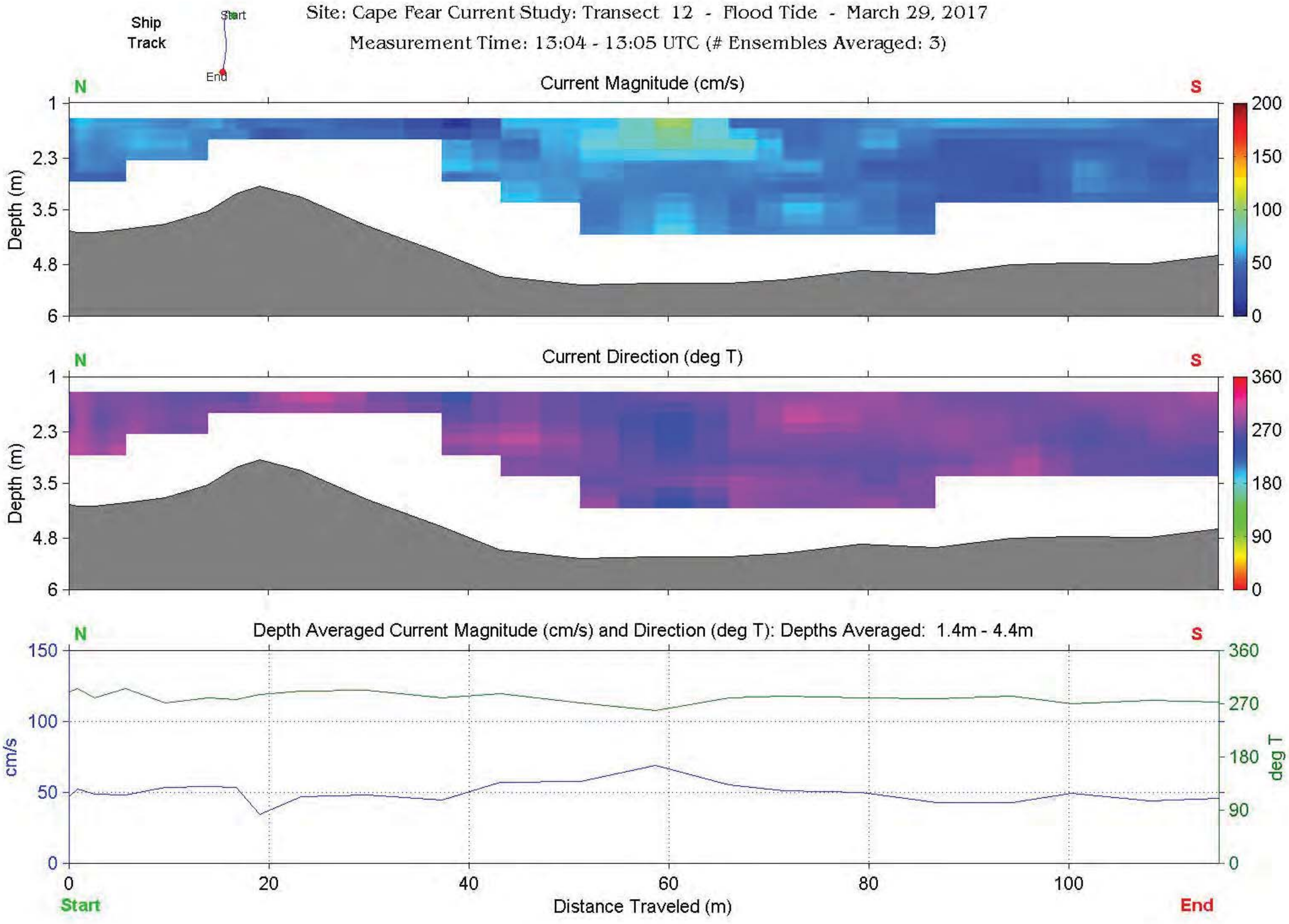



Site: Cape Fear Current Study: Transect 11 - Flood Tide - March 31, 2017

Measurement Time: 12:00 - 12:05 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 29, 2017

Measurement Time: 11:18 - 11:19 UTC (# Ensembles Averaged: 3)

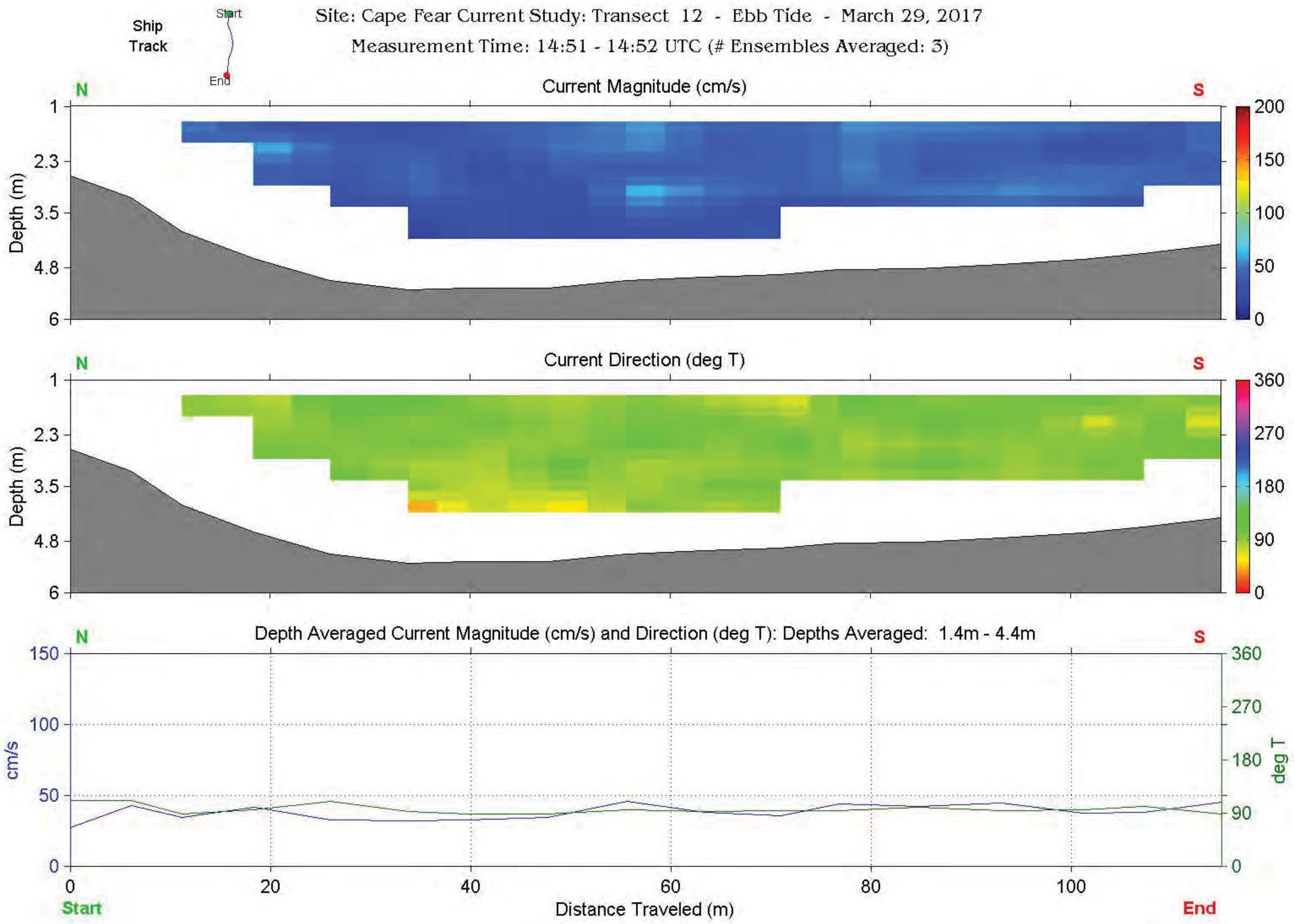


Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 29, 2017

Measurement Time: 13:04 - 13:05 UTC (# Ensembles Averaged: 3)

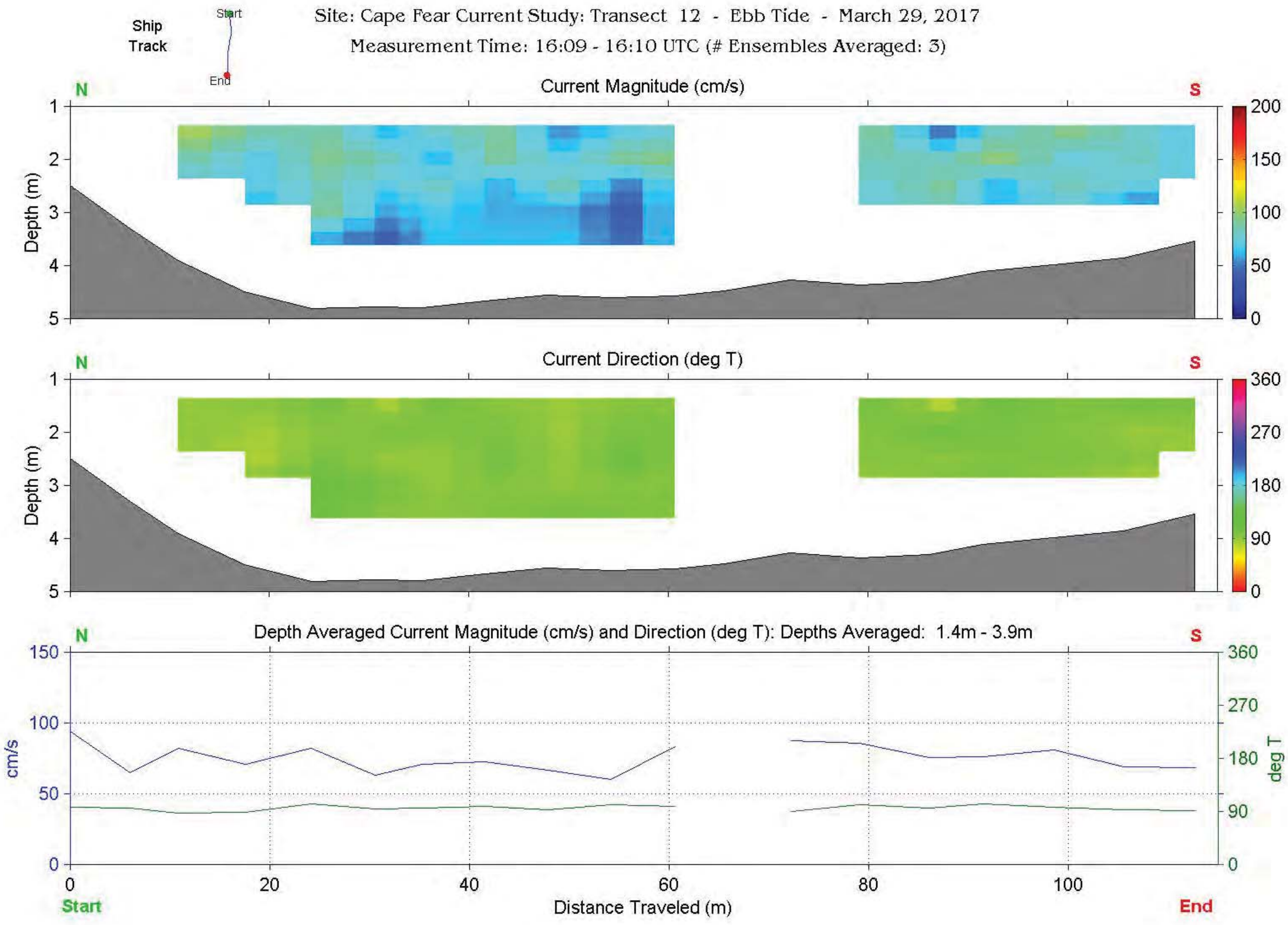
Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 29, 2017

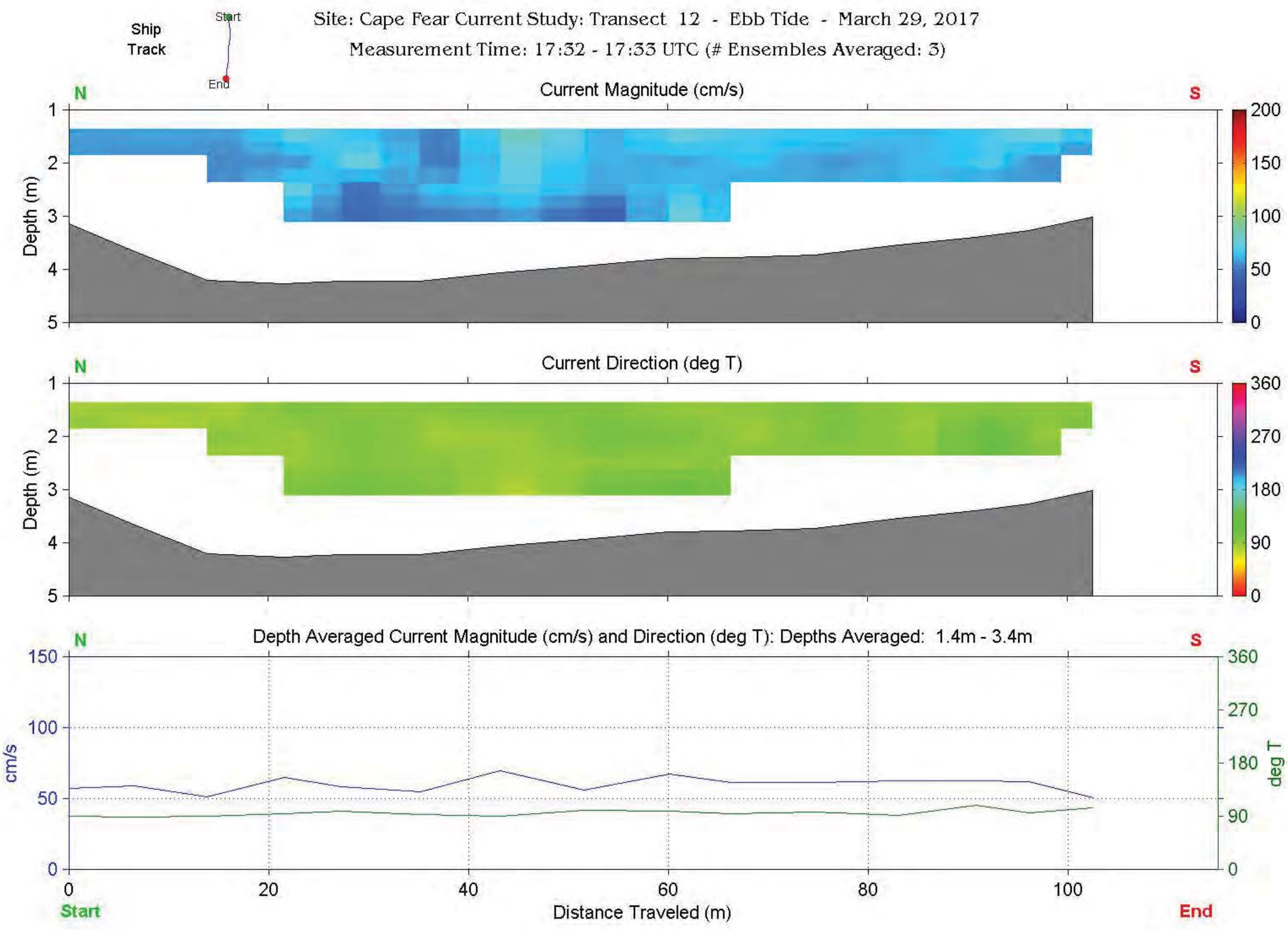
Measurement Time: 14:51 - 14:52 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 29, 2017

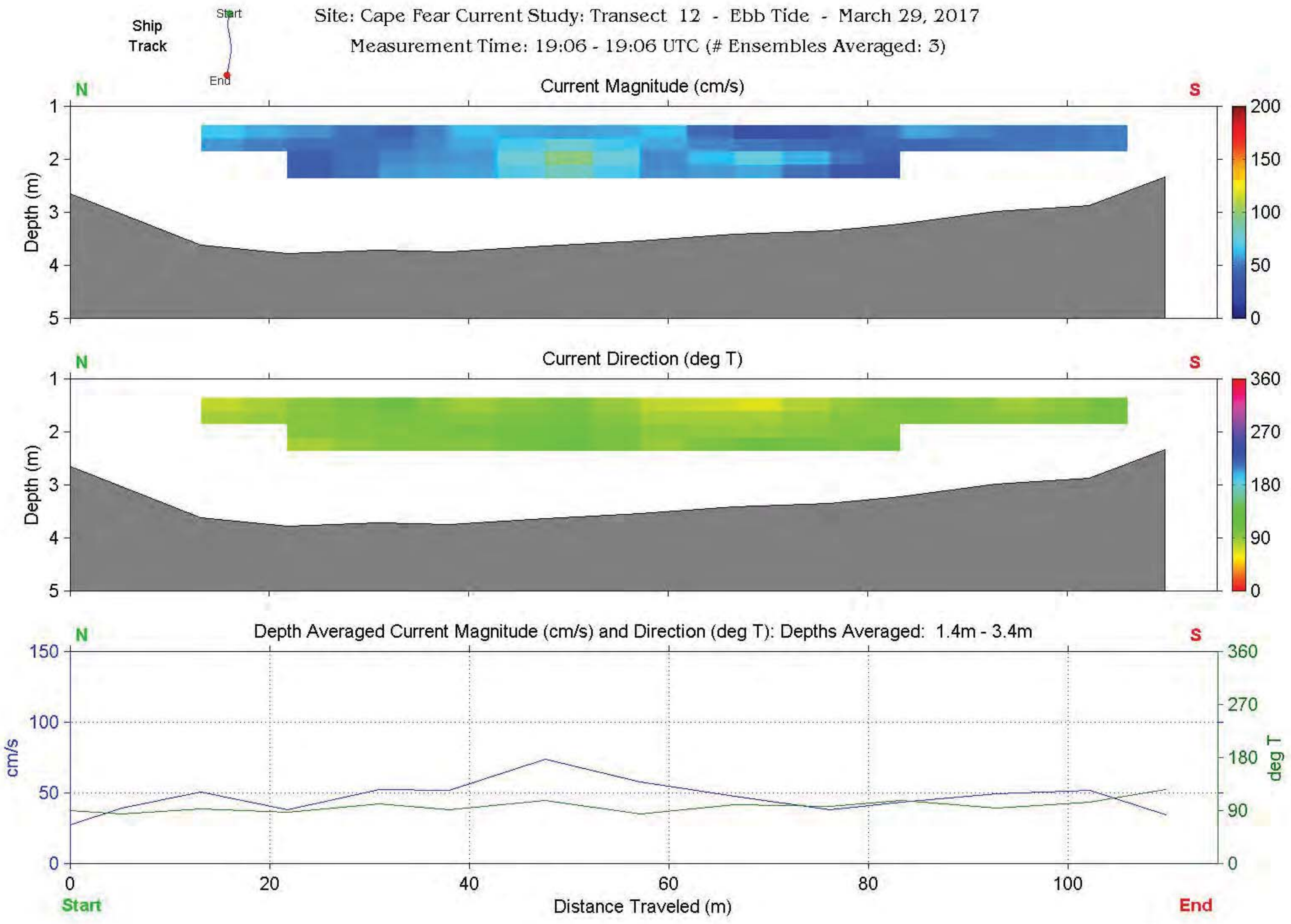
Measurement Time: 16:09 - 16:10 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 29, 2017

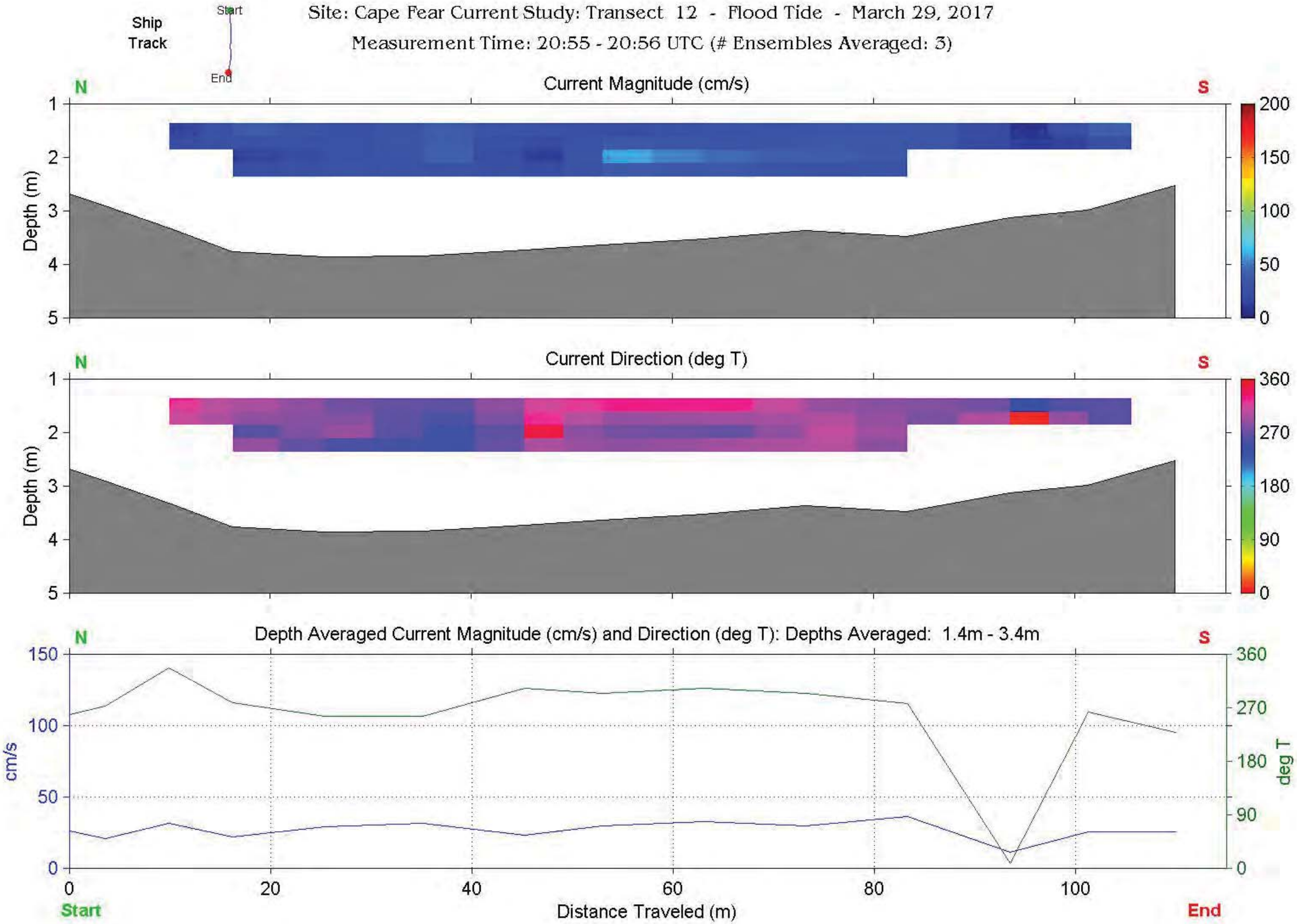
Measurement Time: 17:32 - 17:33 UTC (# Ensembles Averaged: 3)

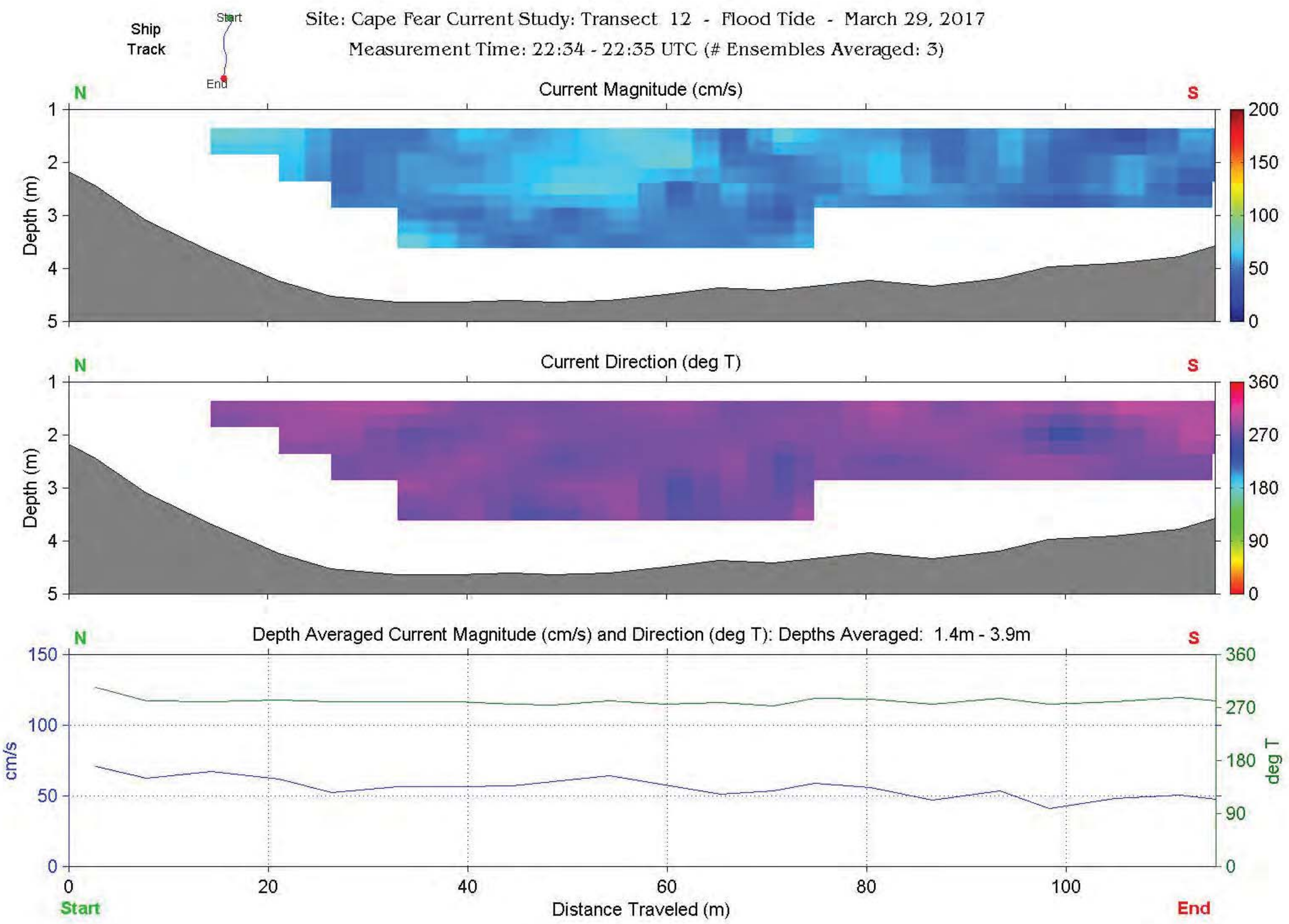

Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 29, 2017

Measurement Time: 19:06 - 19:06 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 29, 2017

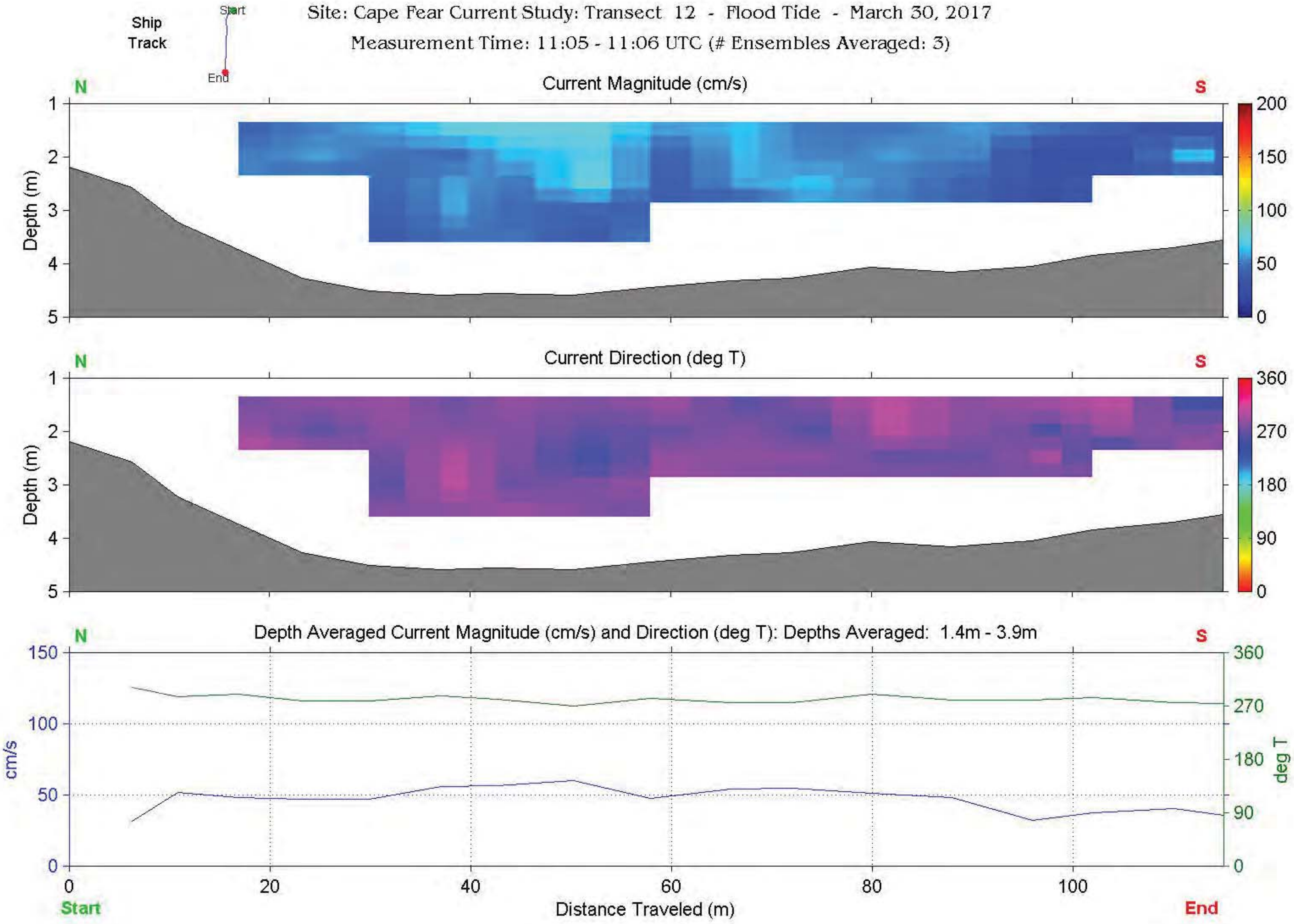
Measurement Time: 20:55 - 20:56 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 29, 2017

Measurement Time: 22:34 - 22:35 UTC (# Ensembles Averaged: 3)

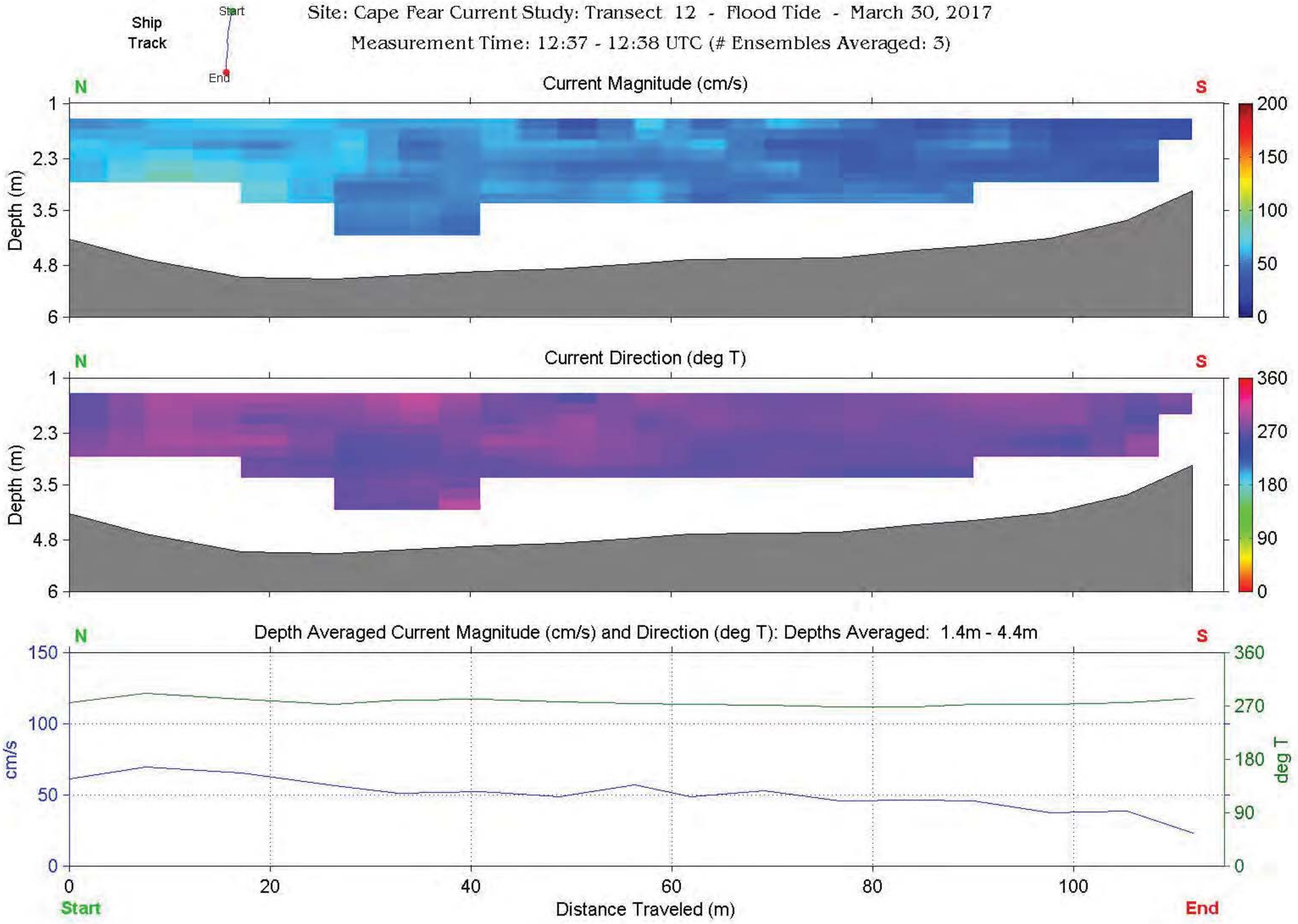


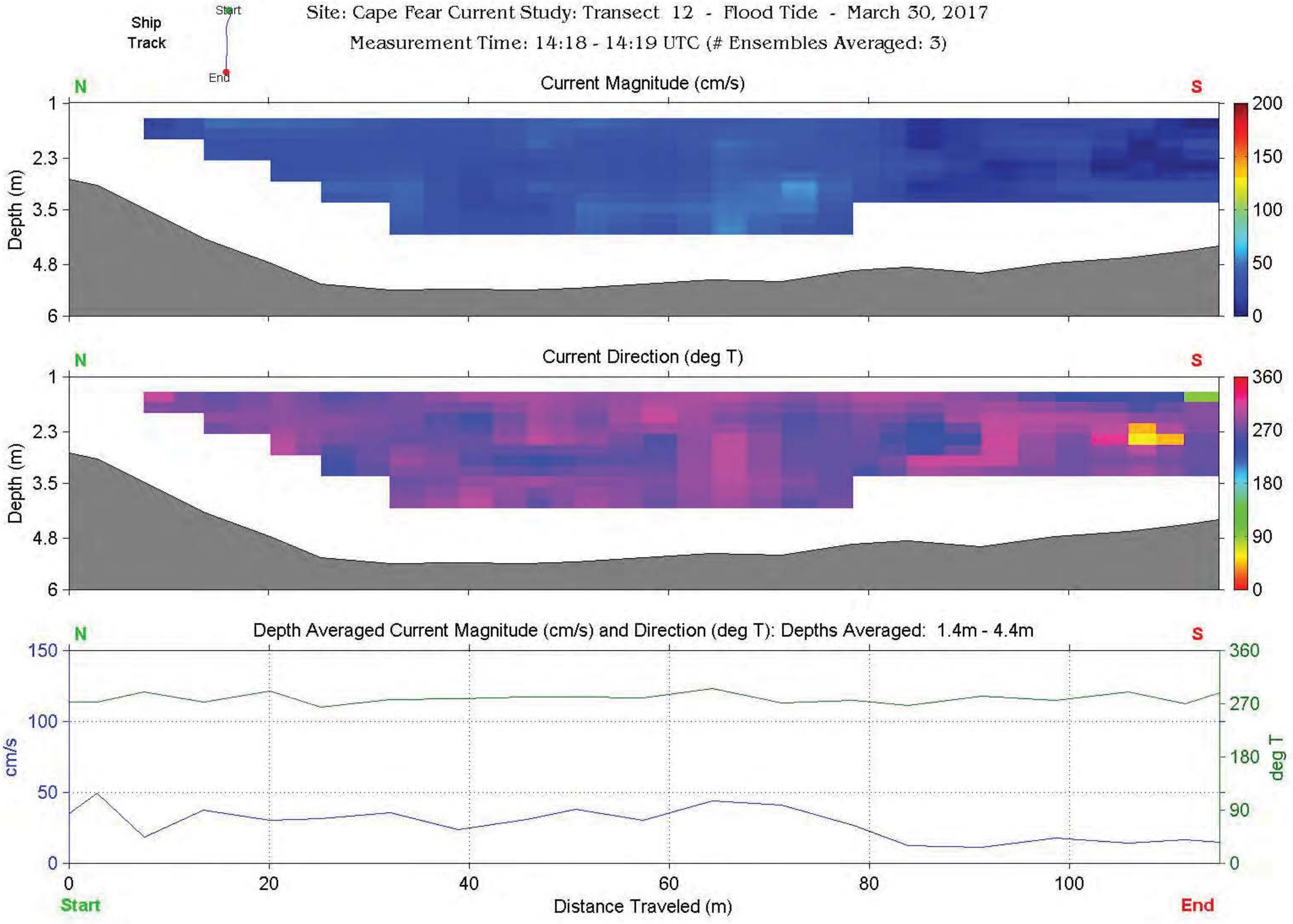
Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 30, 2017

Measurement Time: 11:05 - 11:06 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 30, 2017

Measurement Time: 12:37 - 12:38 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 30, 2017

Measurement Time: 14:18 - 14:19 UTC (# Ensembles Averaged: 3)

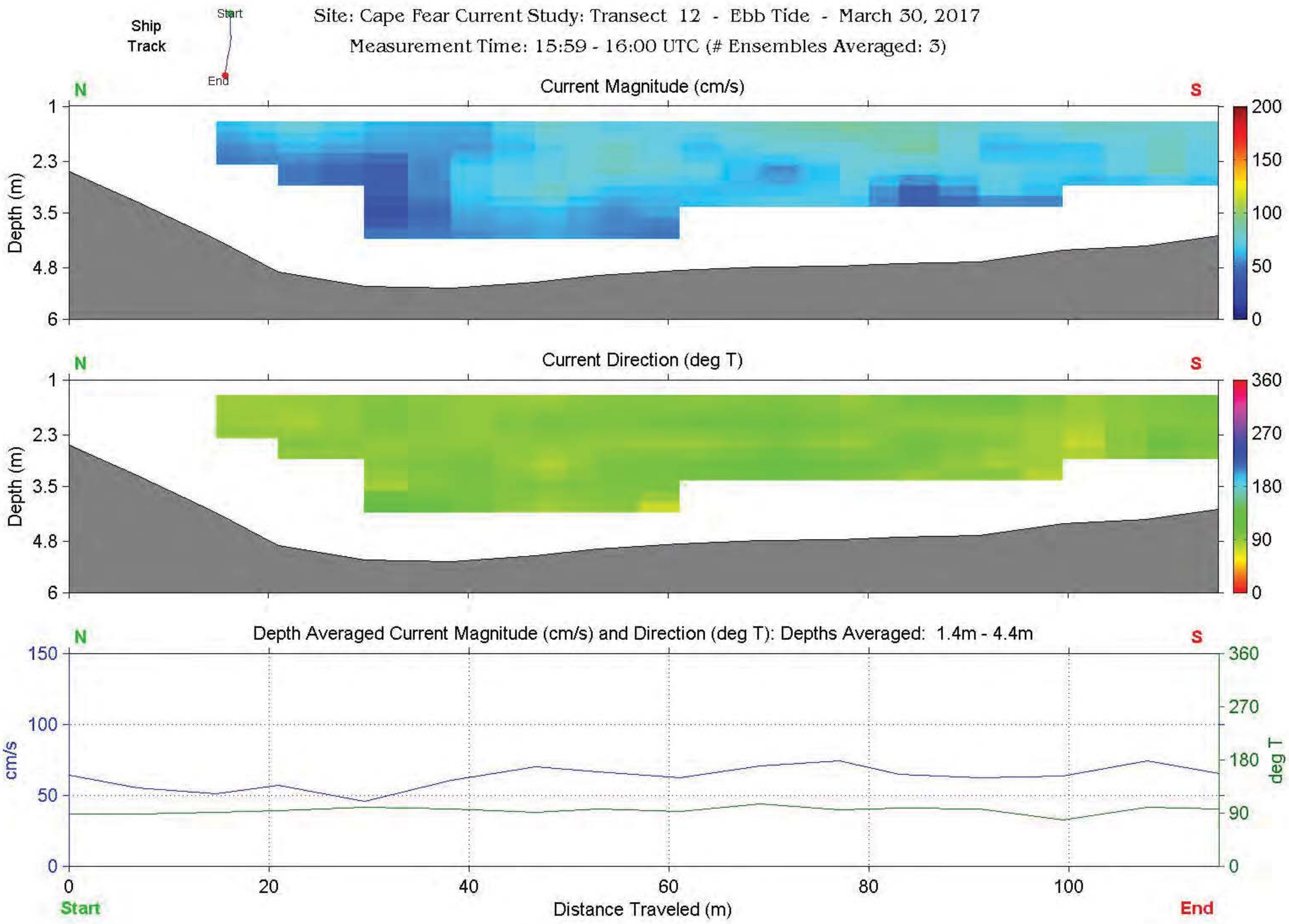
Current Magnitude (cm/s)

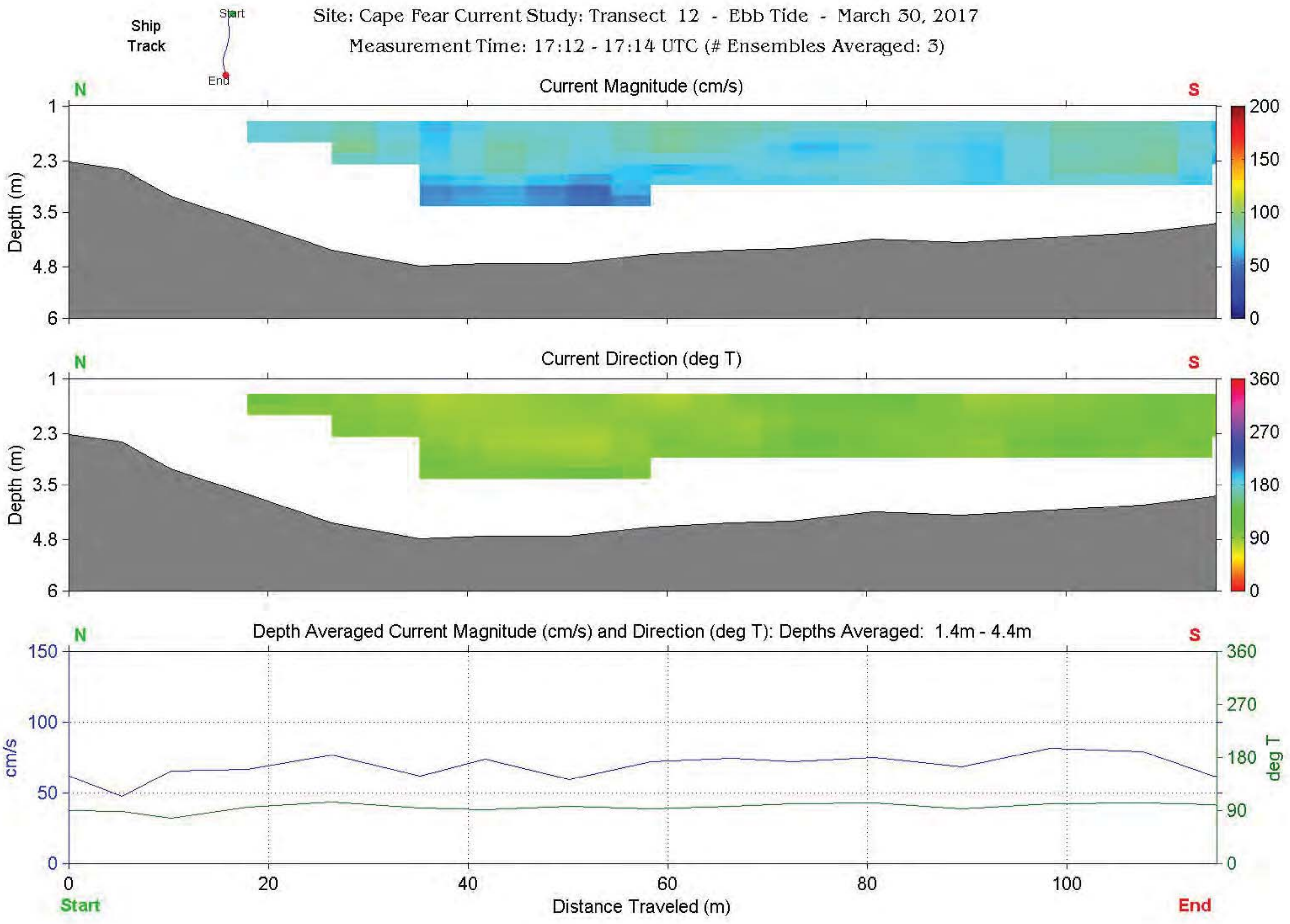
Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.4m - 4.4m

Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 30, 2017

Measurement Time: 15:59 - 16:00 UTC (# Ensembles Averaged: 3)



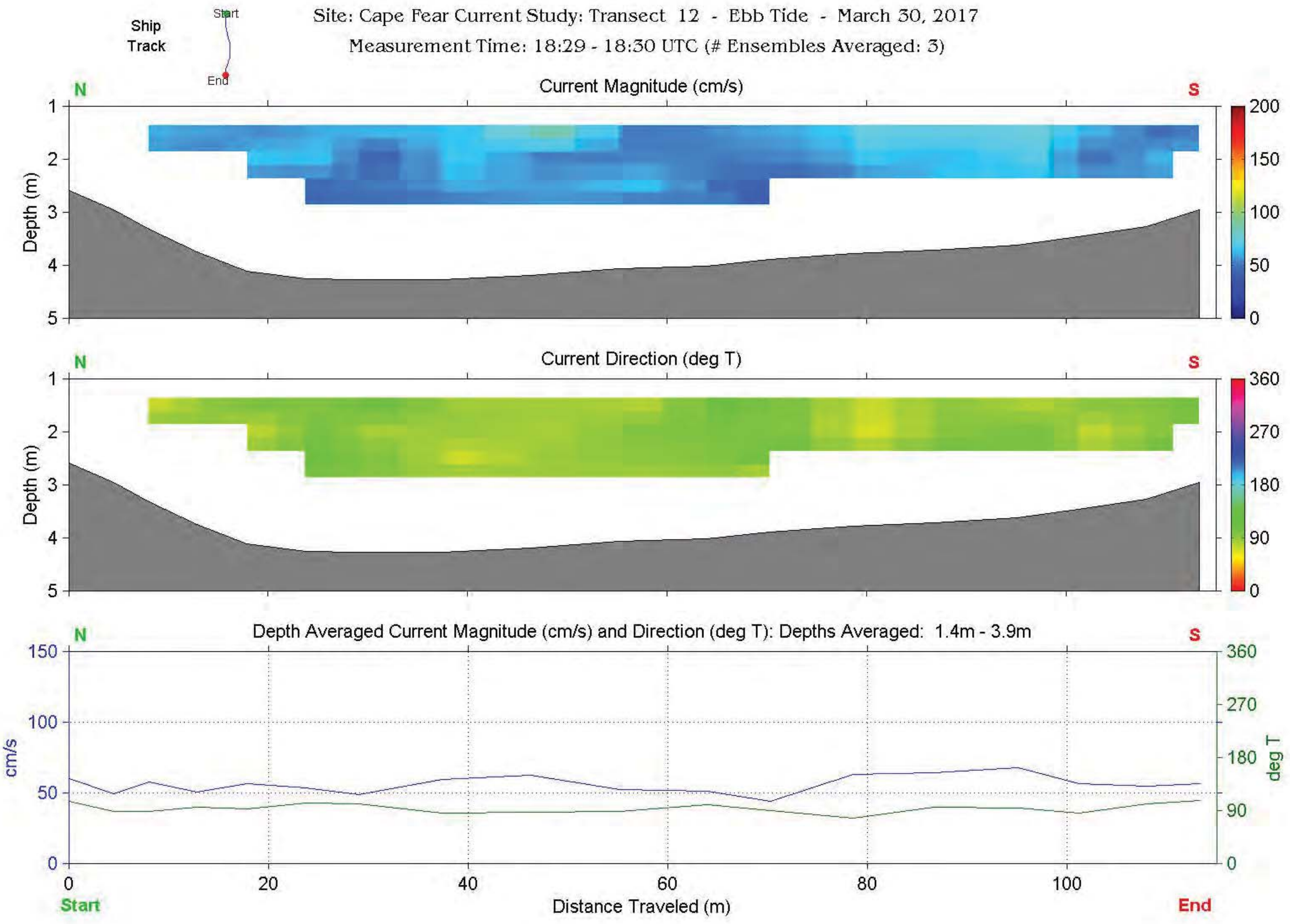


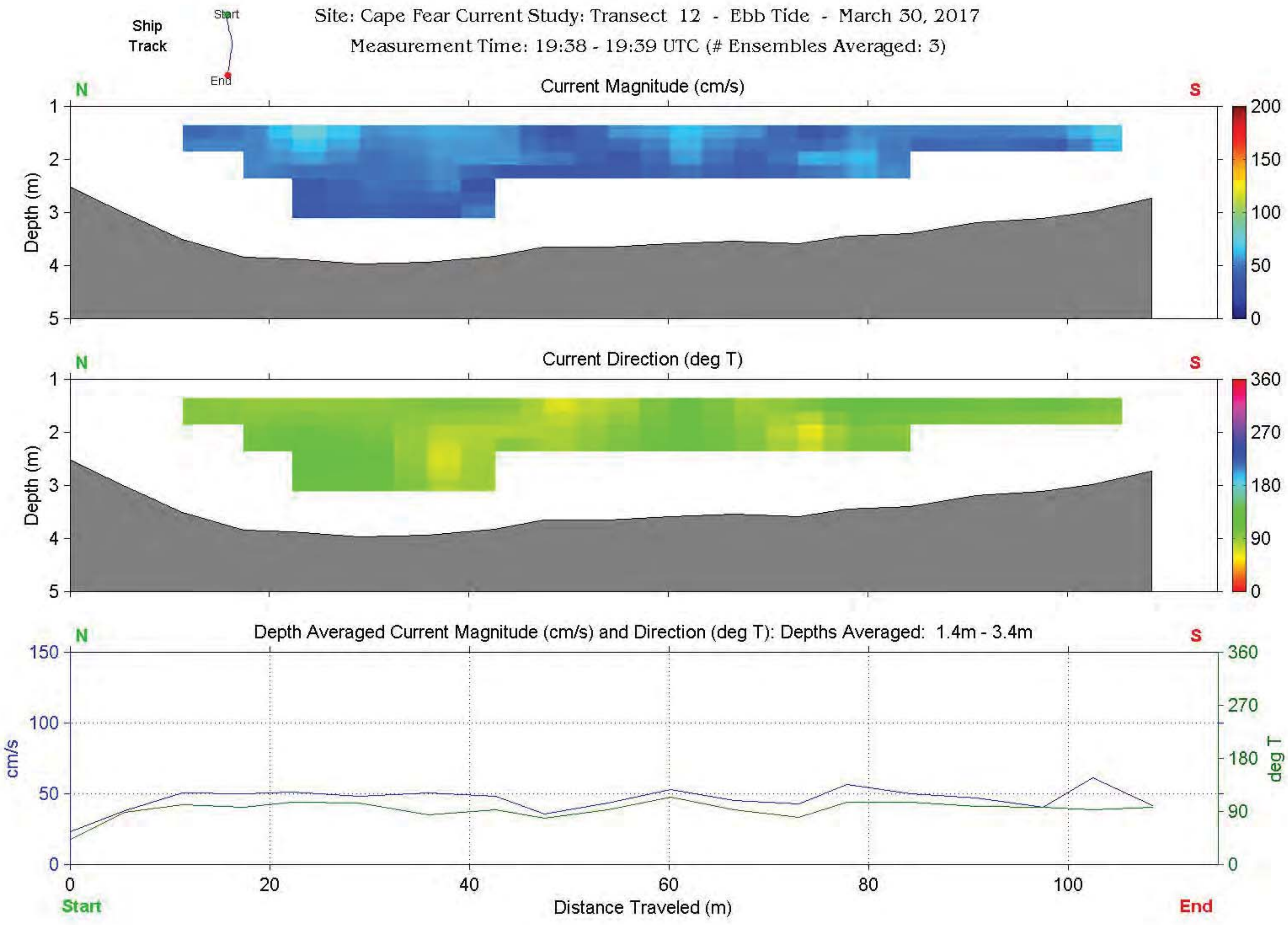
Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 30, 2017

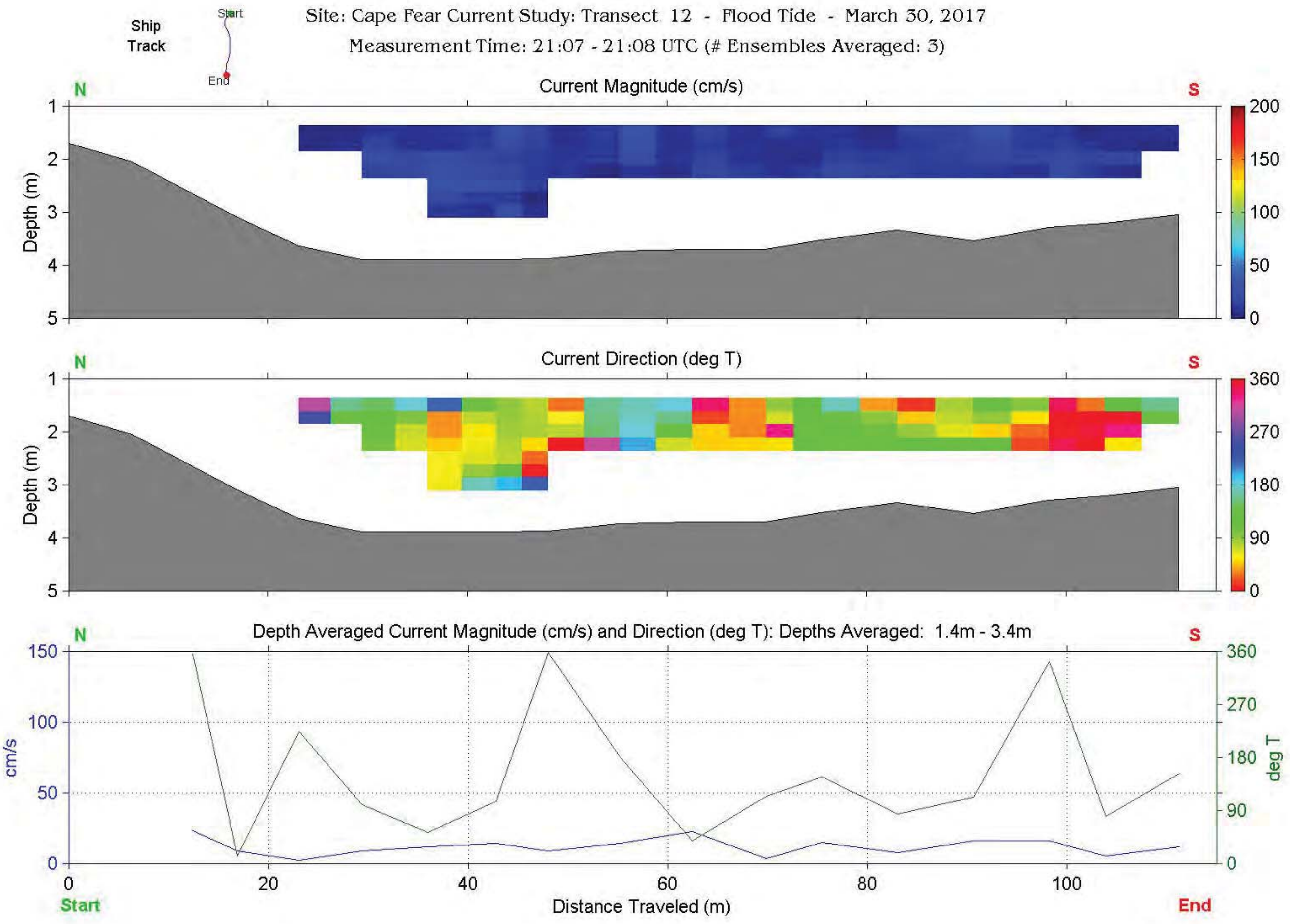
Measurement Time: 17:12 - 17:14 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 30, 2017

Measurement Time: 18:29 - 18:30 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 12 - Ebb Tide - March 30, 2017
Measurement Time: 19:38 - 19:39 UTC (# Ensembles Averaged: 3)
Ship Track
Start
End
Current Magnitude (cm/s)
N
S
Depth (m)
1
2
3
4
5
200
150
100
50
0
Current Direction (deg T)
N
S
Depth (m)
1
2
3
4
5
360
270
180
90
0
Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.4m - 3.4m
N
S
cm/s
150
100
50
0
deg T
360
270
180
90
0
0
20
40
60
80
100
Start
End
Distance Traveled (m)



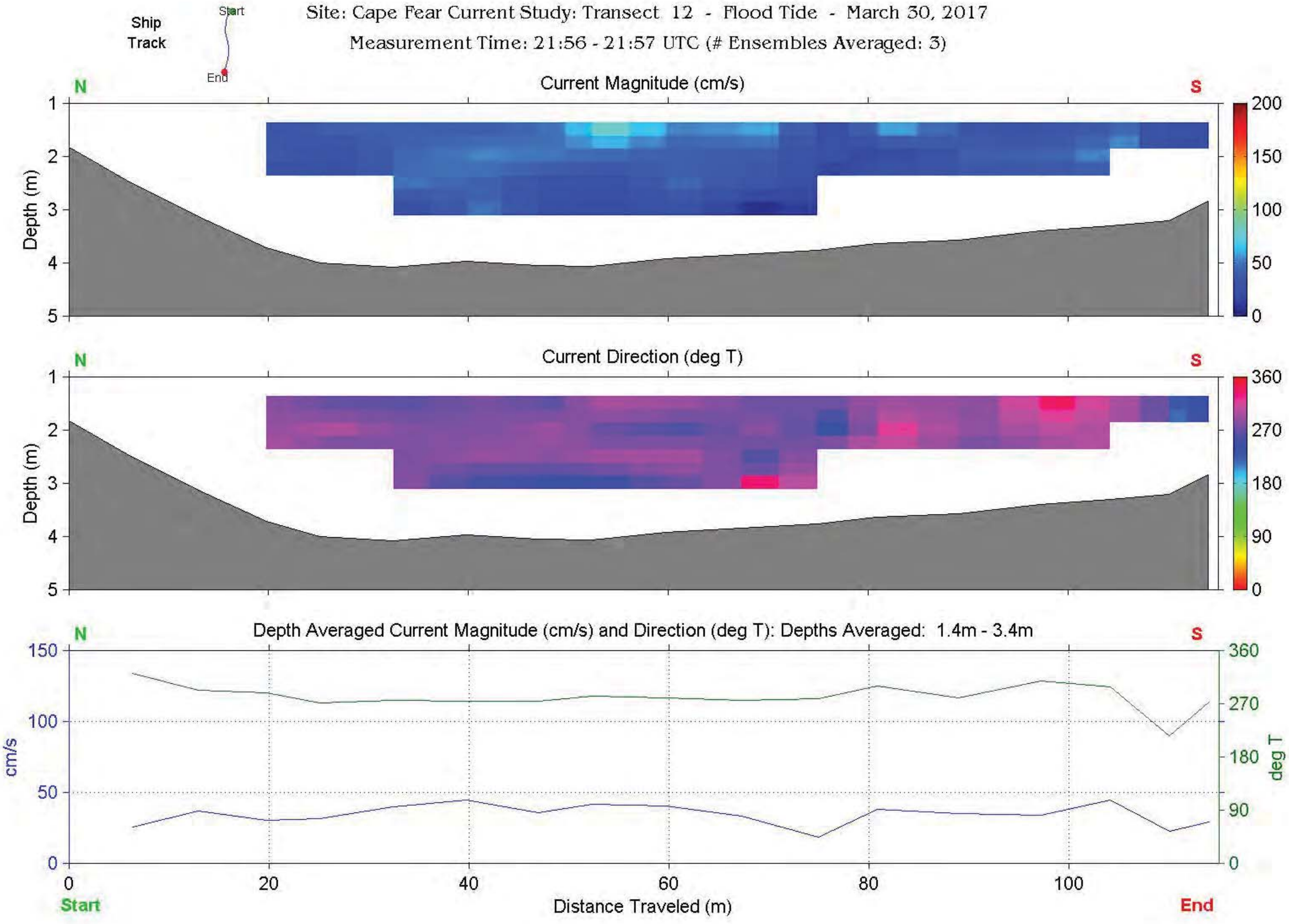
Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 30, 2017

Measurement Time: 21:07 - 21:08 UTC (# Ensembles Averaged: 3)

Current Magnitude (cm/s)

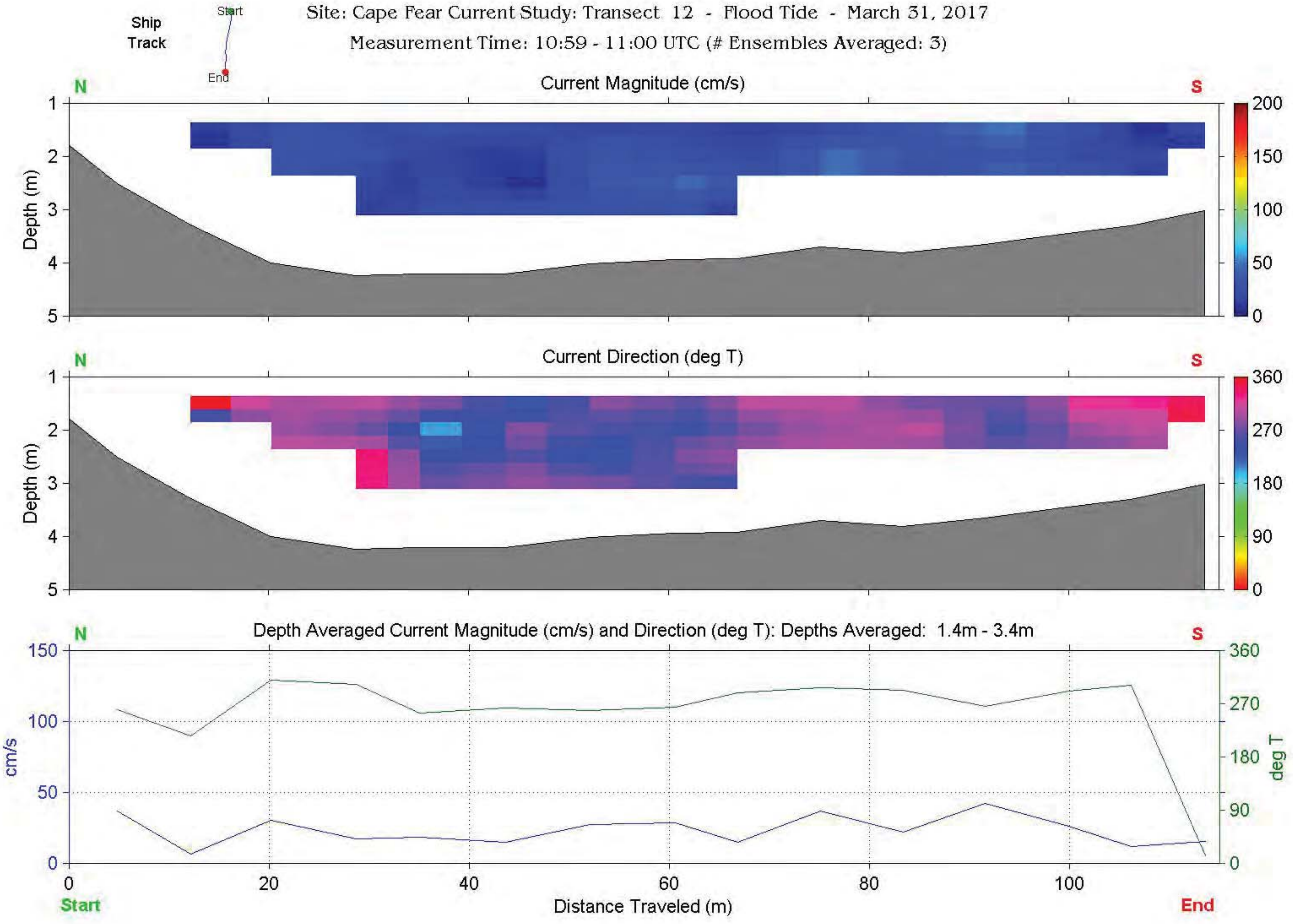
Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.4m - 3.4m



Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 30, 2017

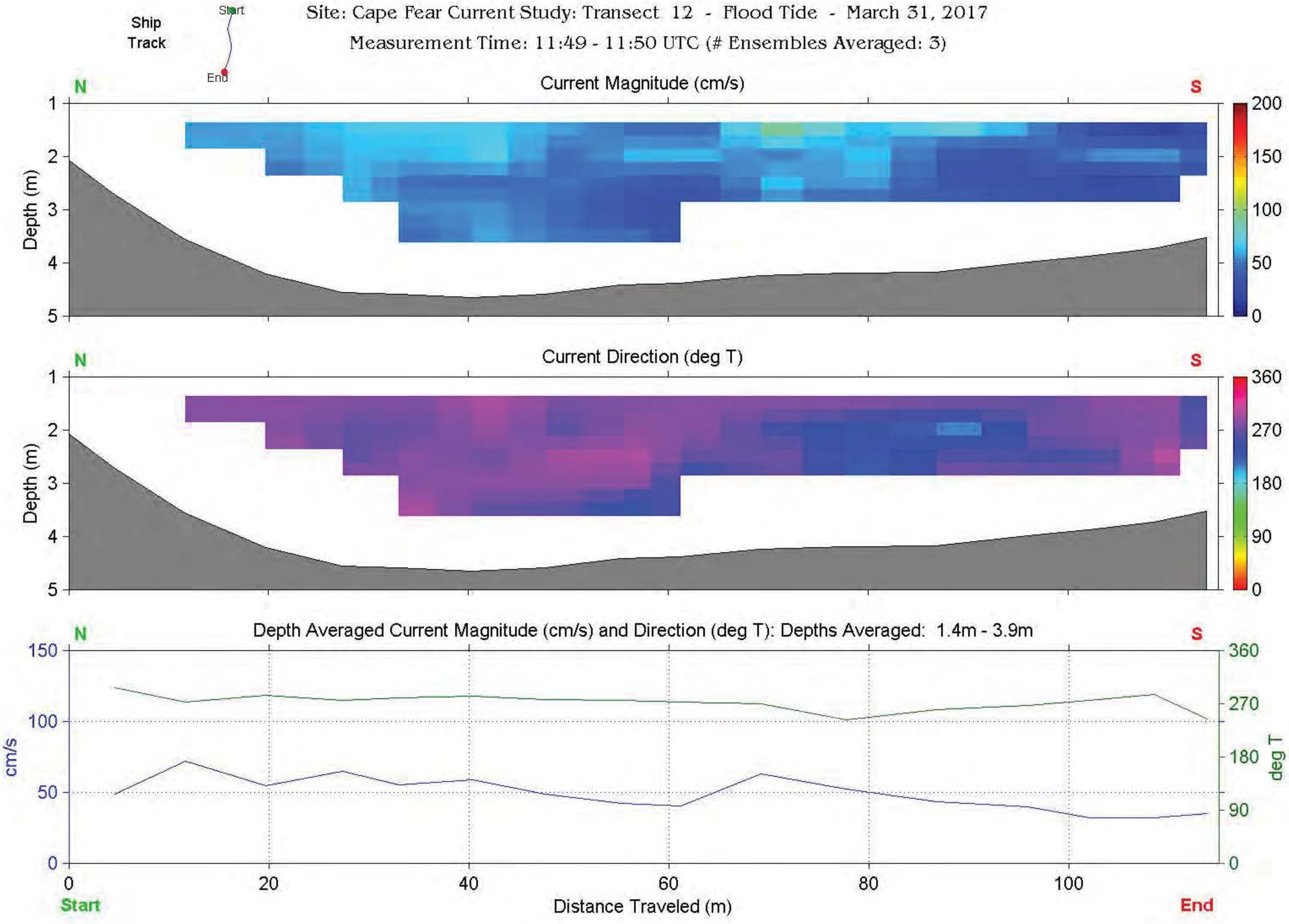
Measurement Time: 21:56 - 21:57 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 31, 2017

Measurement Time: 10:59 - 11:00 UTC (# Ensembles Averaged: 3)

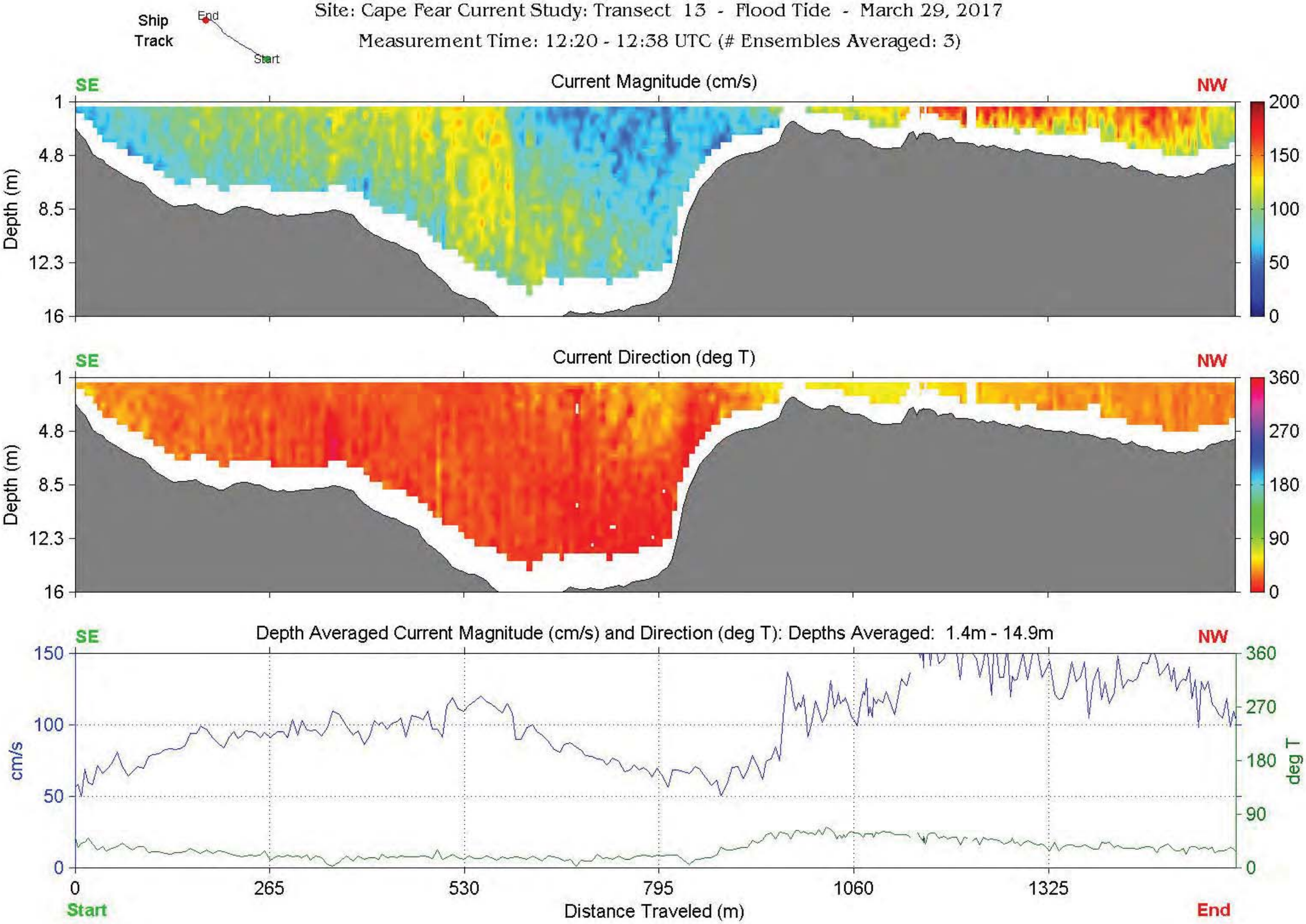
Site: Cape Fear Current Study: Transect 12 - Flood Tide - March 31, 2017

Measurement Time: 11:49 - 11:50 UTC (# Ensembles Averaged: 3)



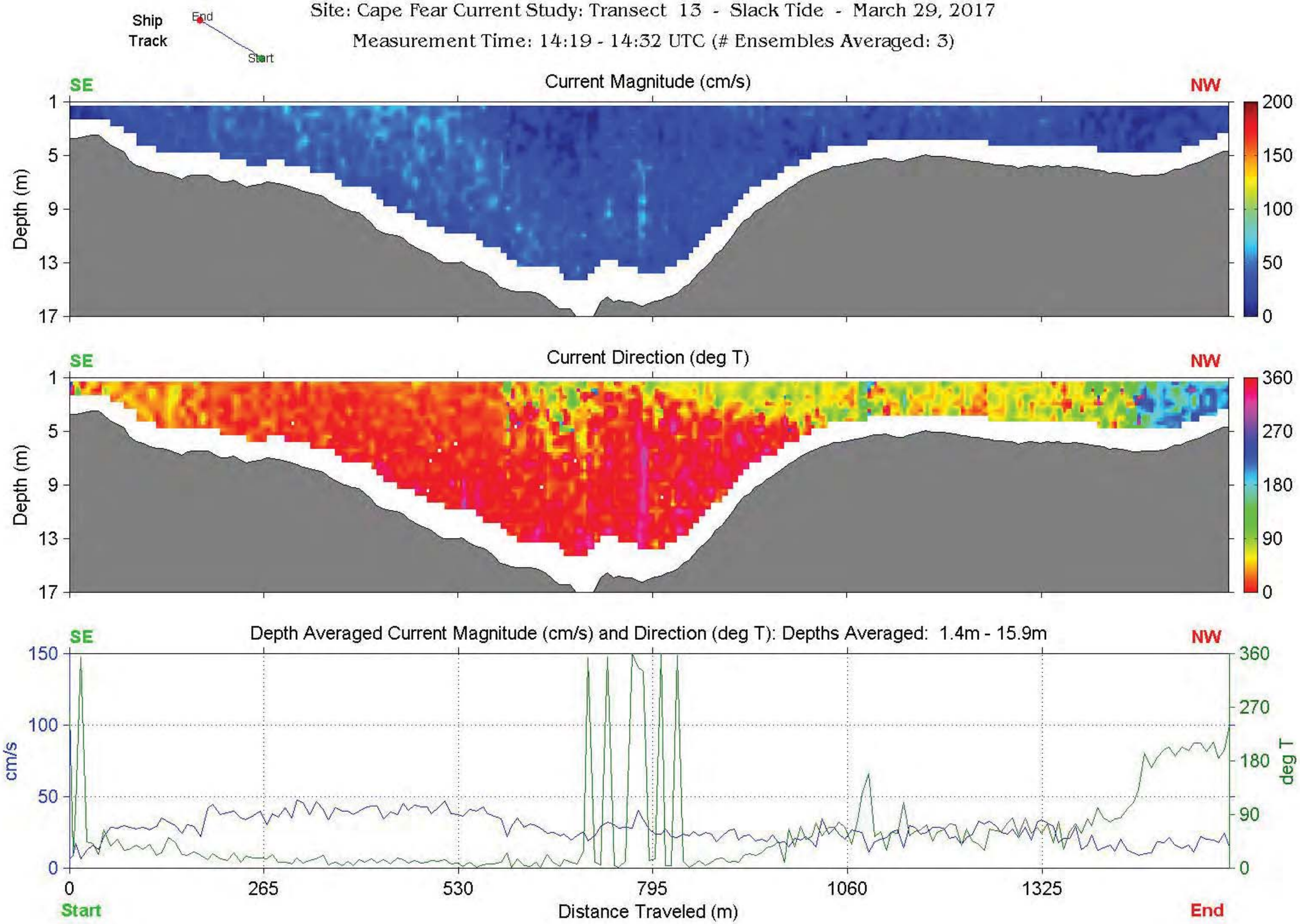
Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 29, 2017

Measurement Time: 12:20 - 12:38 UTC (# Ensembles Averaged: 3)



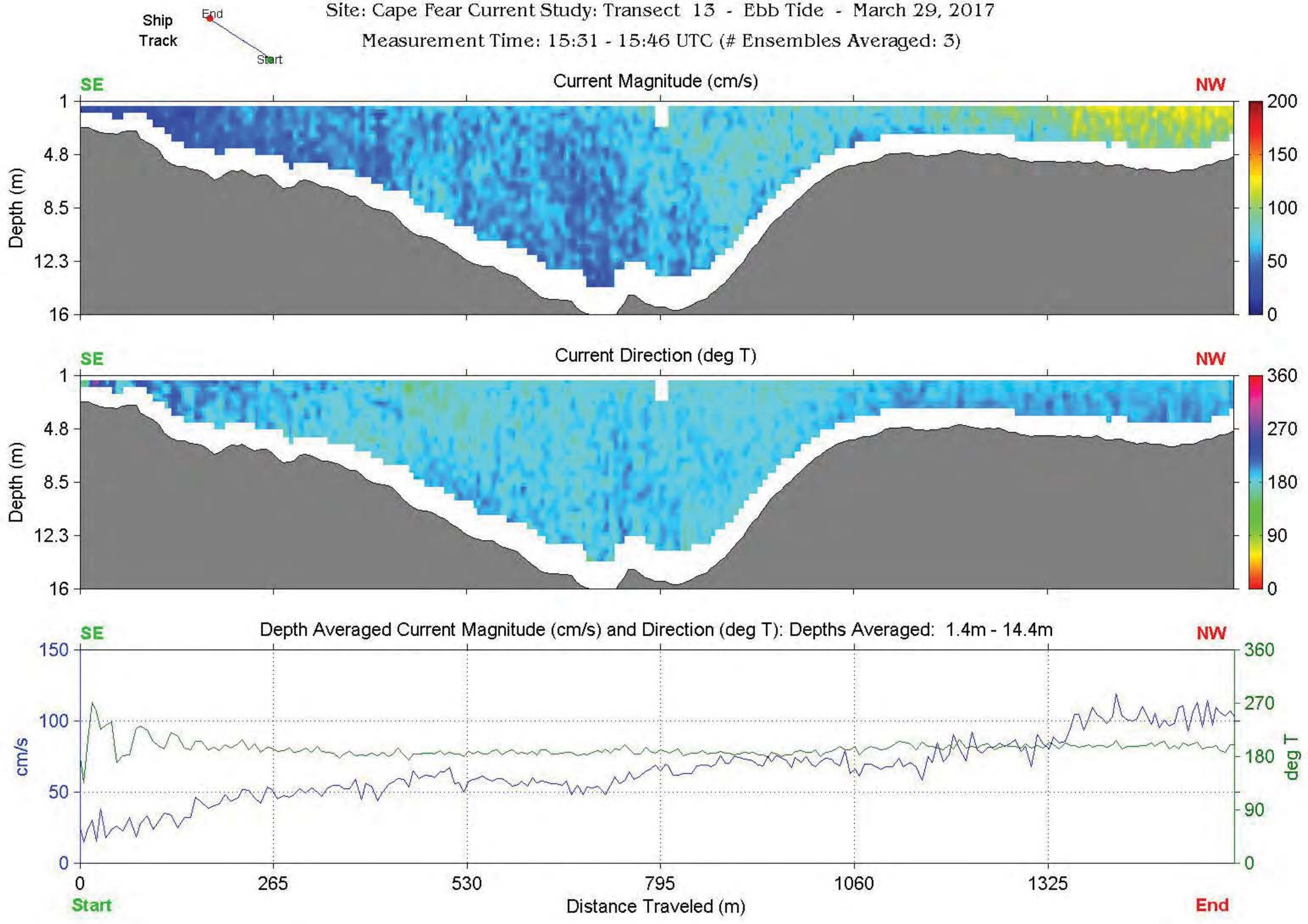
Site: Cape Fear Current Study: Transect 13 - Slack Tide - March 29, 2017

Measurement Time: 14:19 - 14:32 UTC (# Ensembles Averaged: 3)



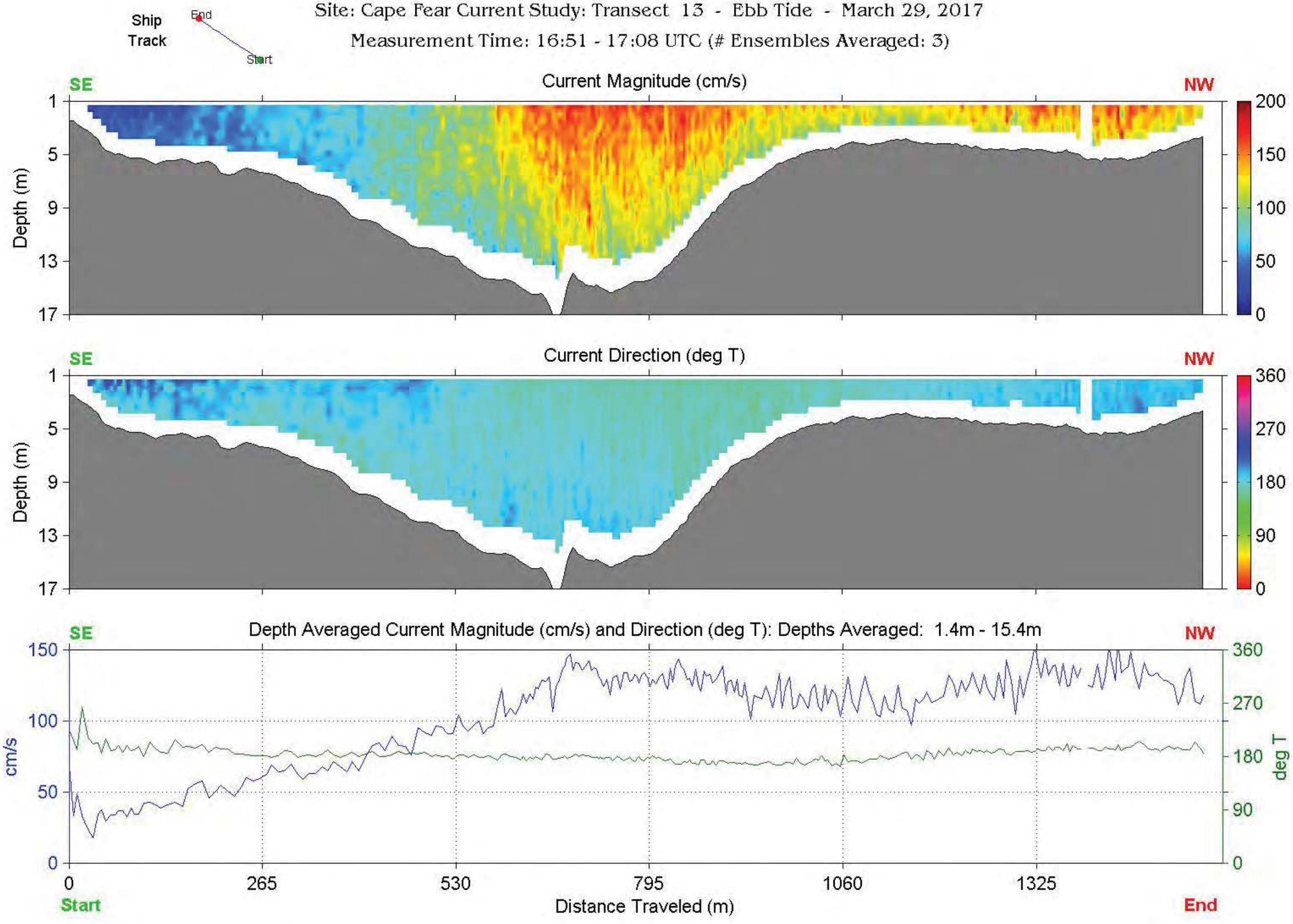
Site: Cape Fear Current Study: Transect 13 - Ebb Tide - March 29, 2017

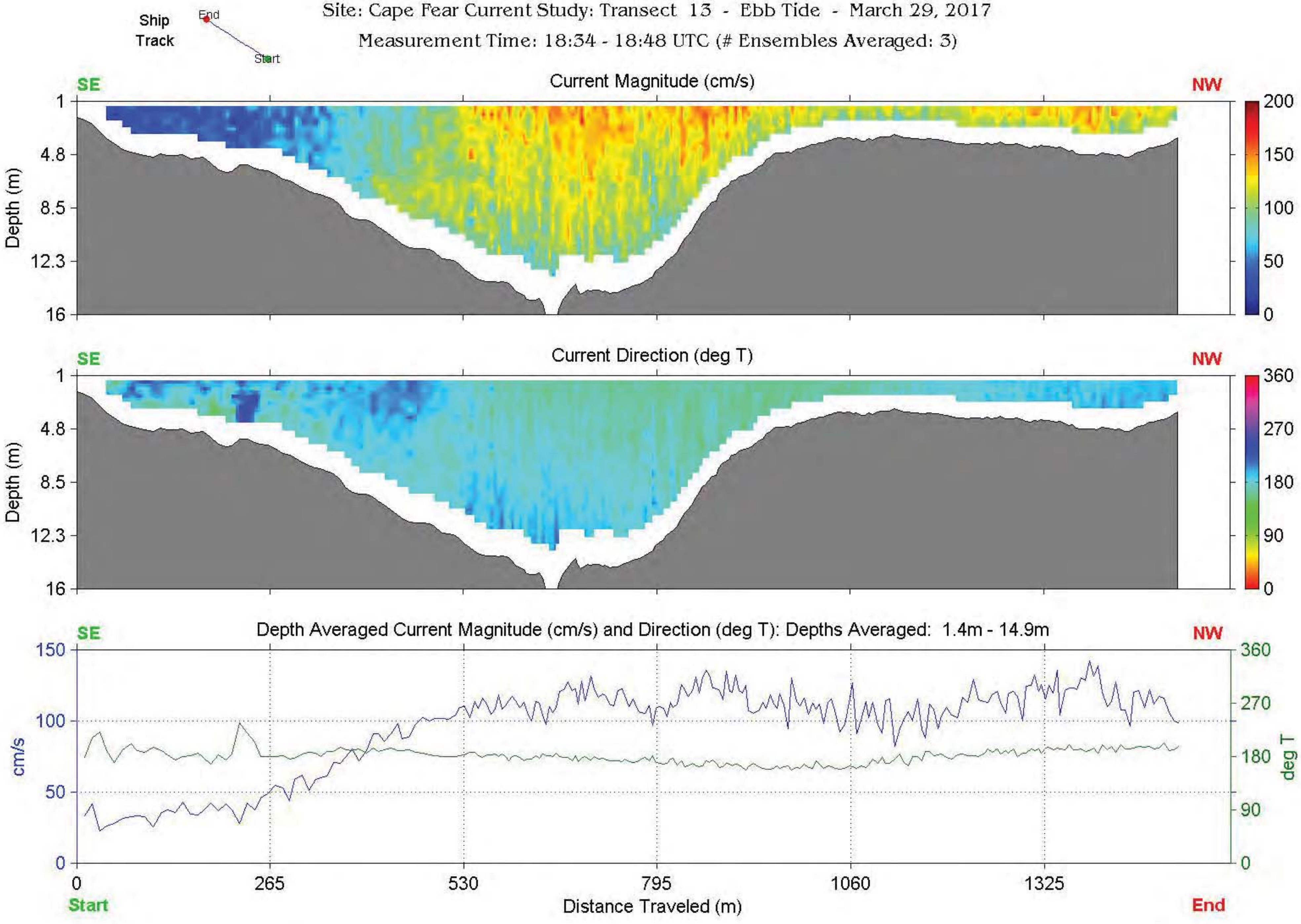
Measurement Time: 15:31 - 15:46 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 13 - Ebb Tide - March 29, 2017

Measurement Time: 16:51 - 17:08 UTC (# Ensembles Averaged: 3)



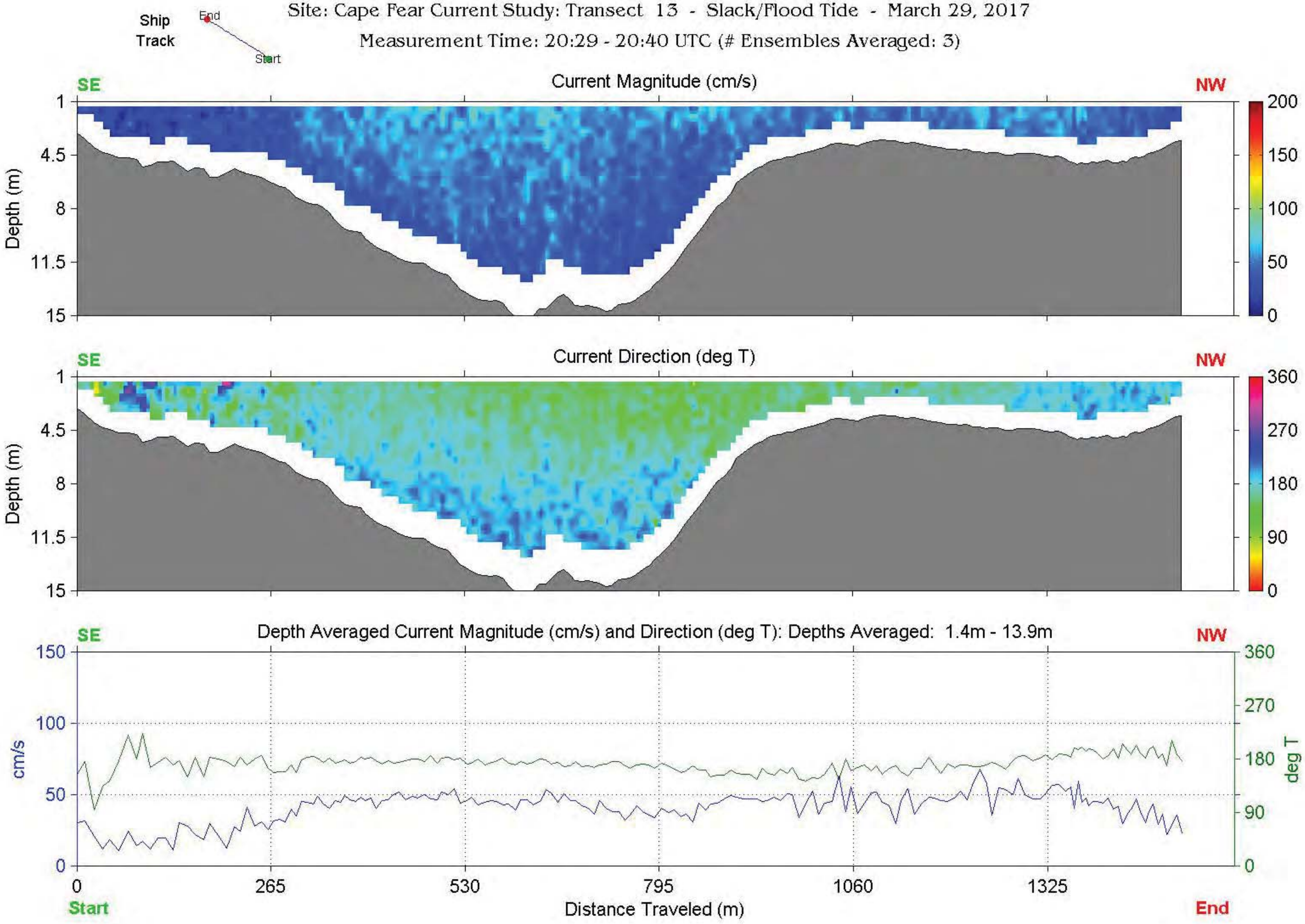


Site: Cape Fear Current Study: Transect 13 - Ebb Tide - March 29, 2017

Measurement Time: 18:34 - 18:48 UTC (# Ensembles Averaged: 3)

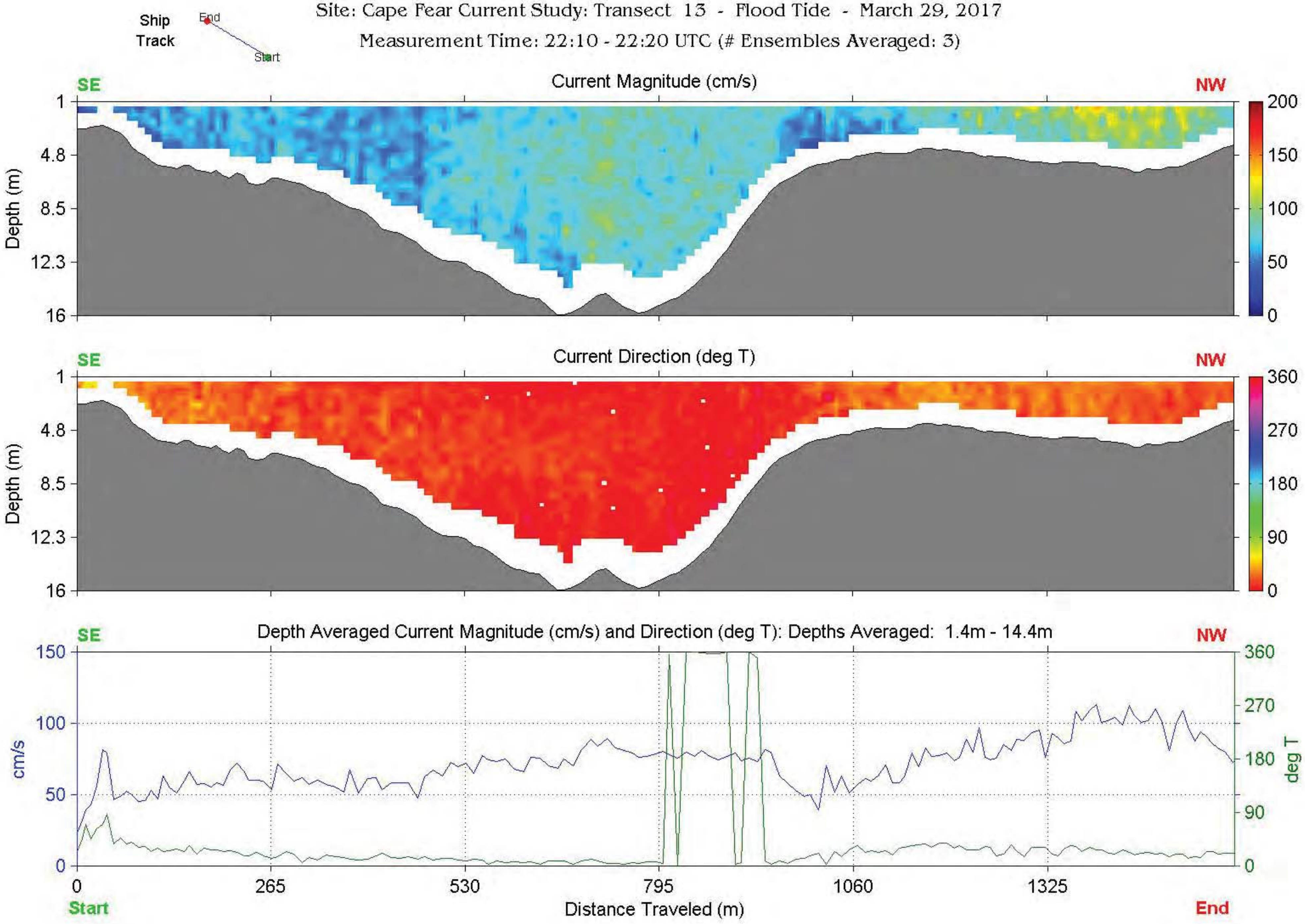
Site: Cape Fear Current Study: Transect 13 - Slack/Flood Tide - March 29, 2017

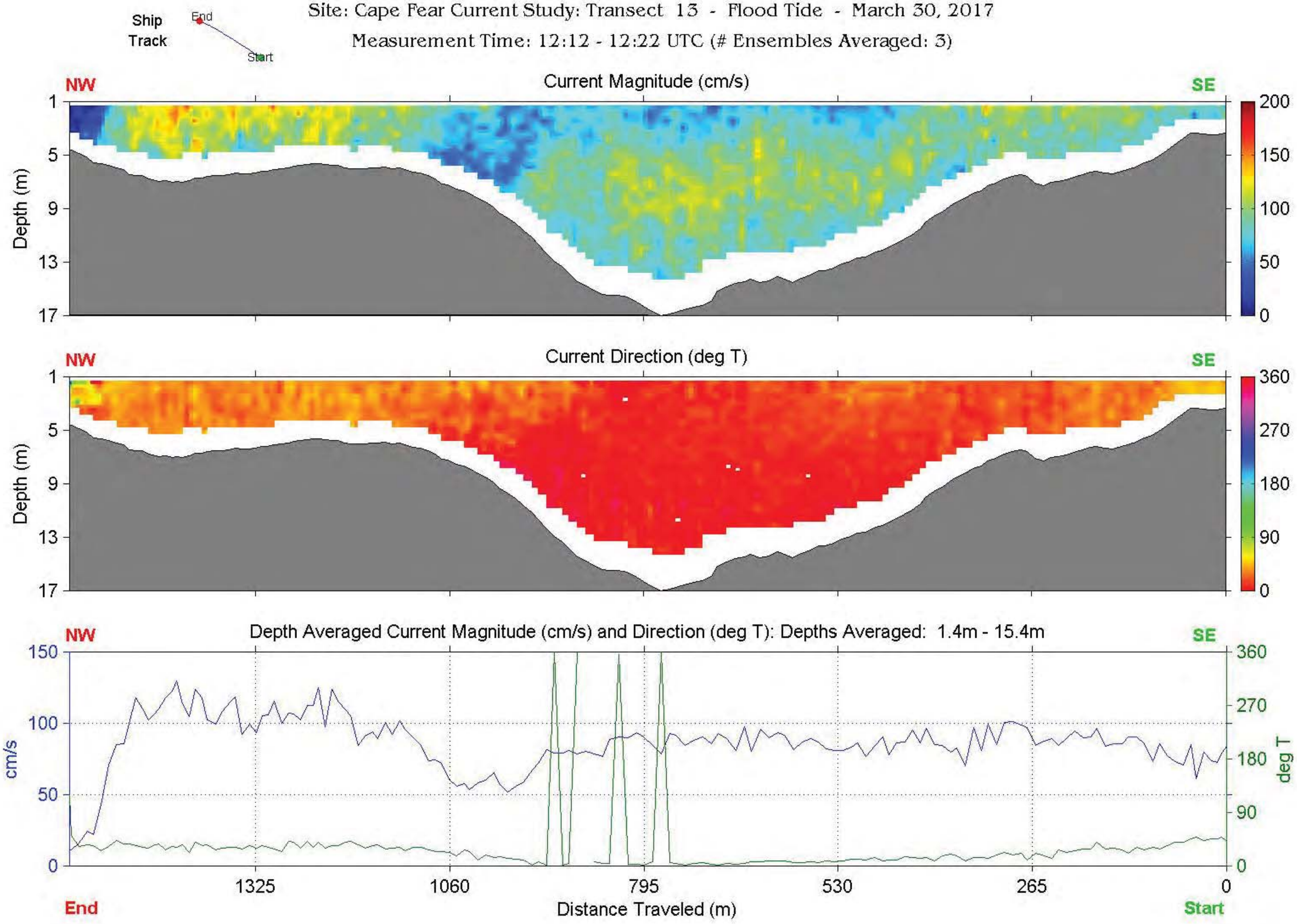
Measurement Time: 20:29 - 20:40 UTC (# Ensembles Averaged: 3)



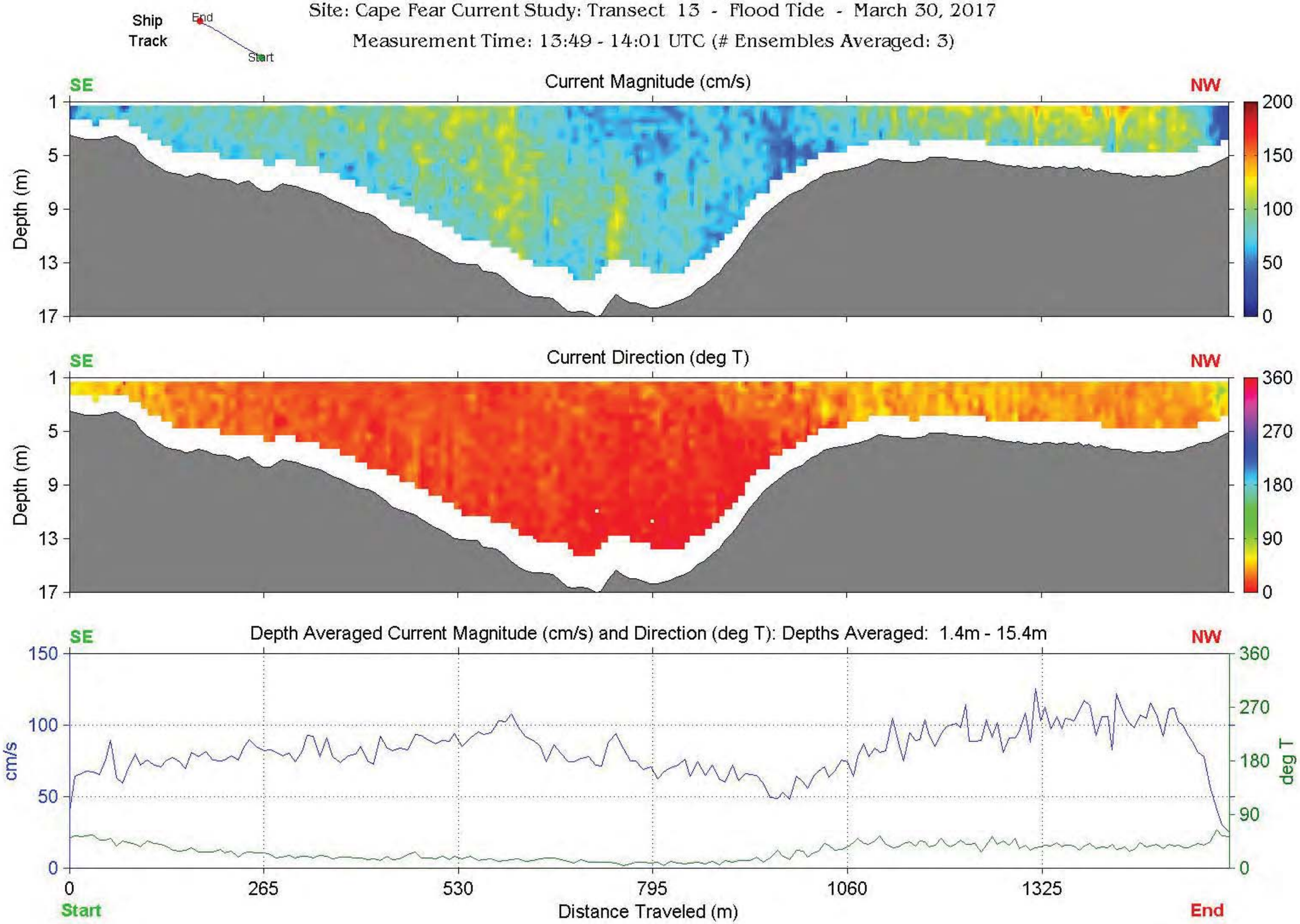
Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 29, 2017

Measurement Time: 22:10 - 22:20 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 30, 2017

Measurement Time: 12:12 - 12:22 UTC (# Ensembles Averaged: 3)

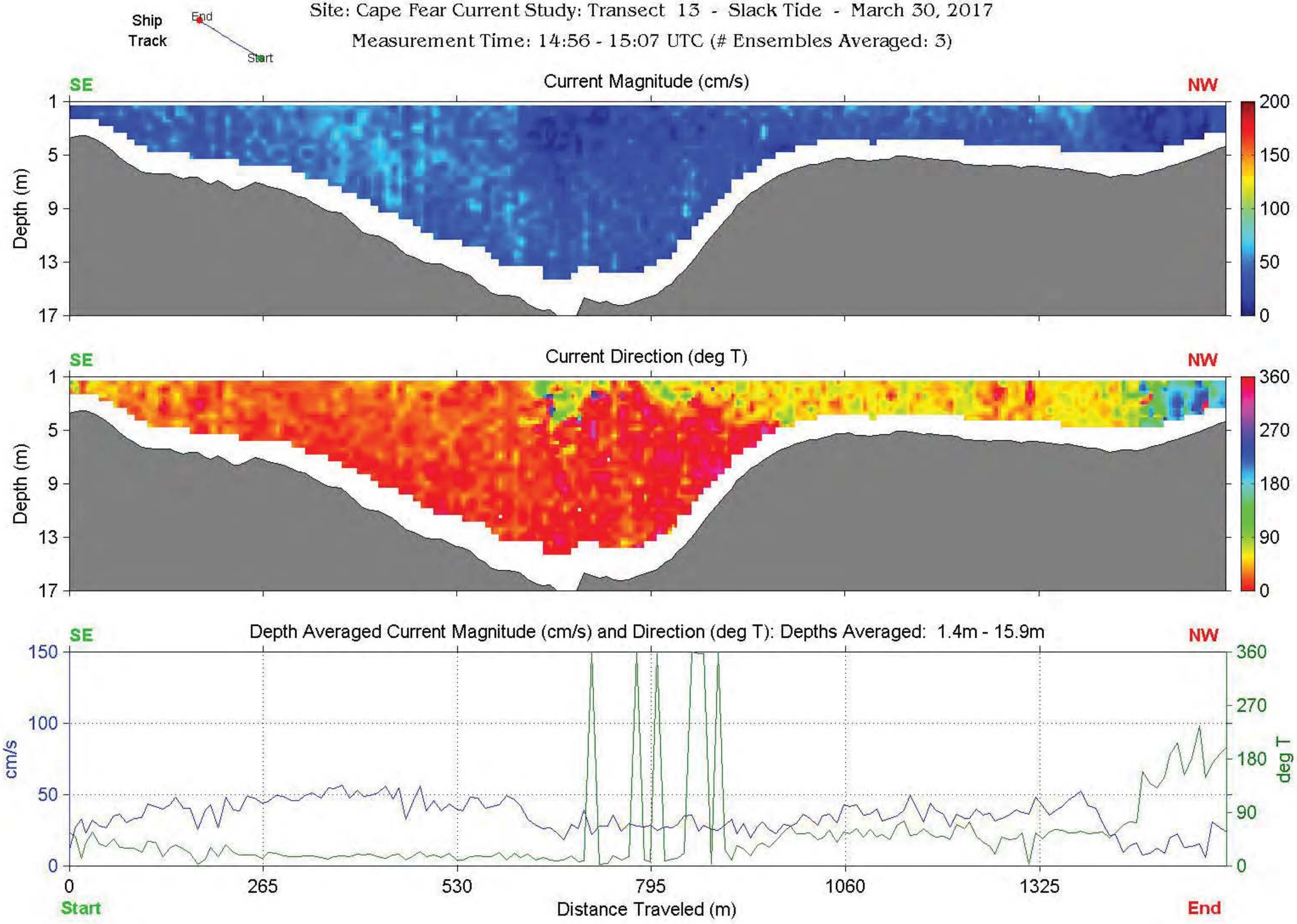


Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 30, 2017

Measurement Time: 13:49 - 14:01 UTC (# Ensembles Averaged: 3)

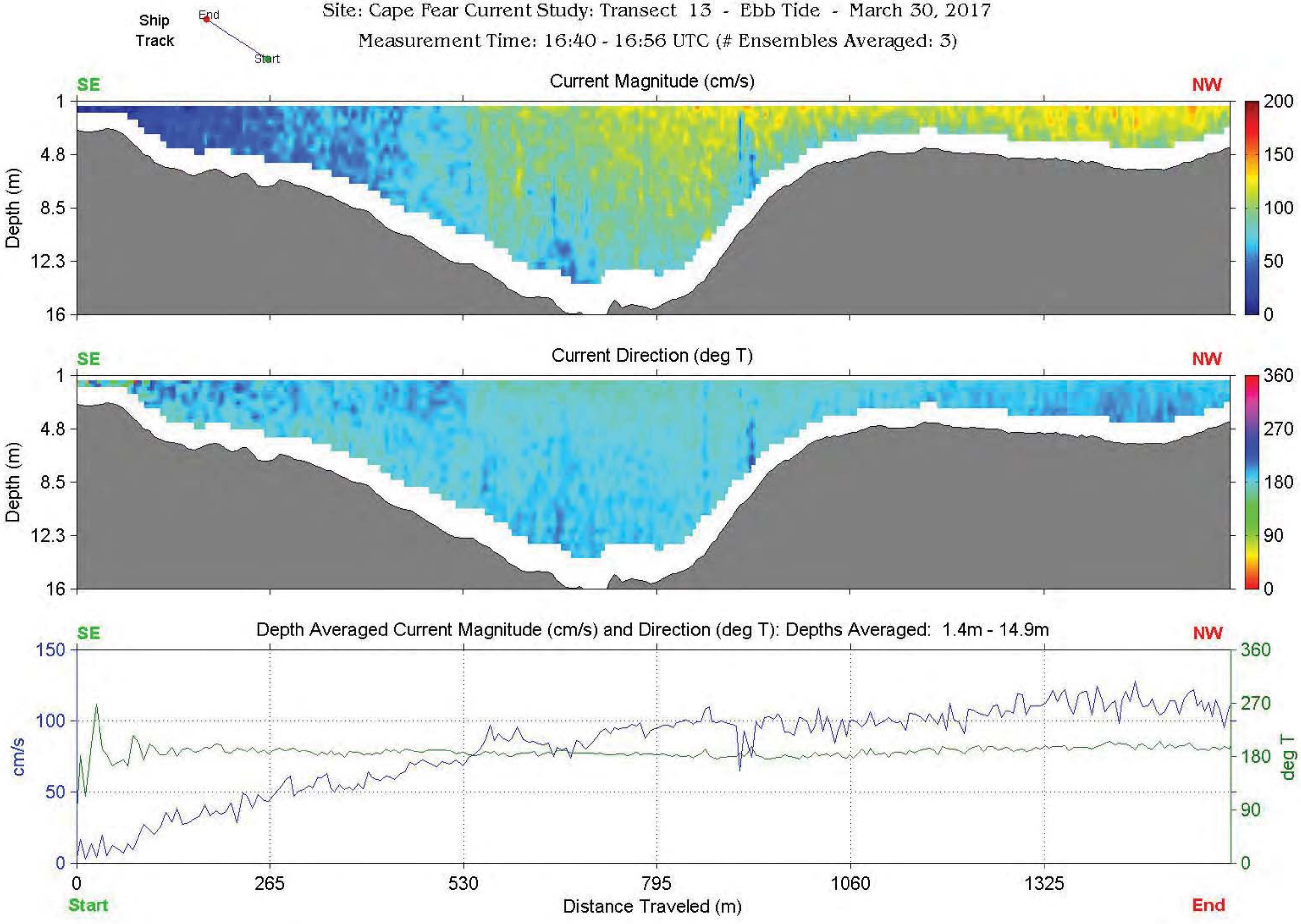
Site: Cape Fear Current Study: Transect 13 - Slack Tide - March 30, 2017

Measurement Time: 14:56 - 15:07 UTC (# Ensembles Averaged: 3)



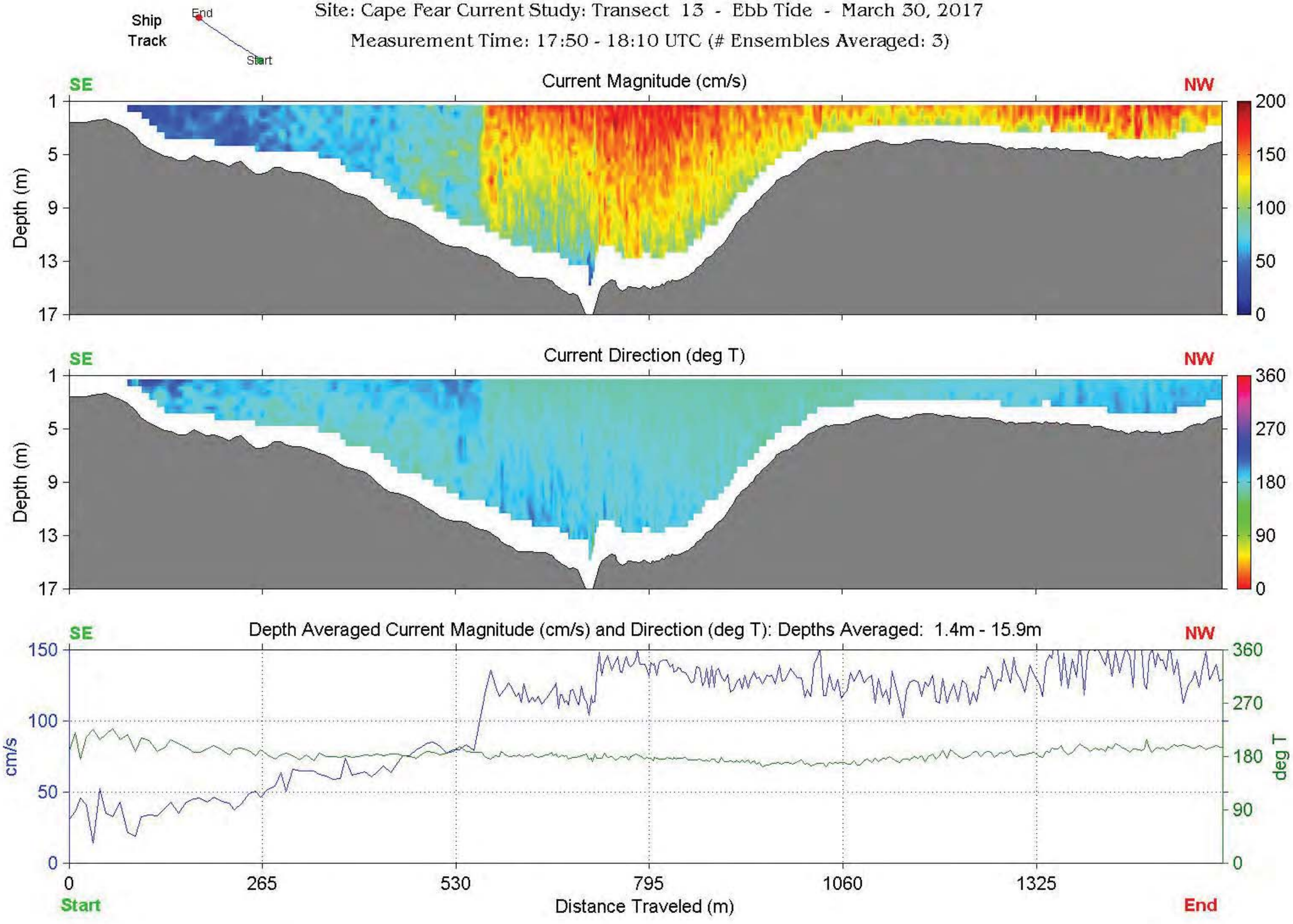
Site: Cape Fear Current Study: Transect 13 - Ebb Tide - March 30, 2017

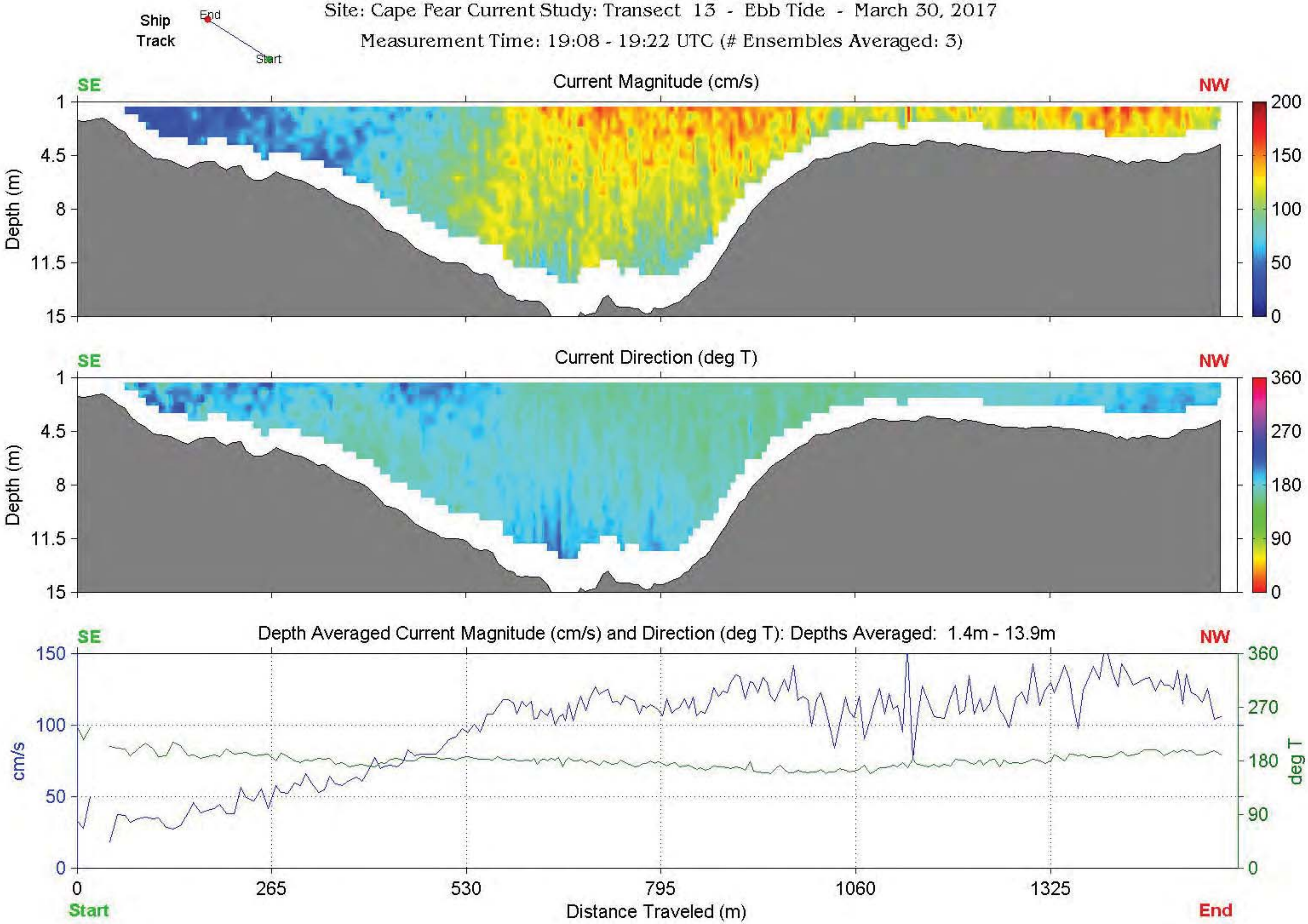
Measurement Time: 16:40 - 16:56 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 13 - Ebb Tide - March 30, 2017

Measurement Time: 17:50 - 18:10 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 13 - Ebb Tide - March 30, 2017

Measurement Time: 19:08 - 19:22 UTC (# Ensembles Averaged: 3)

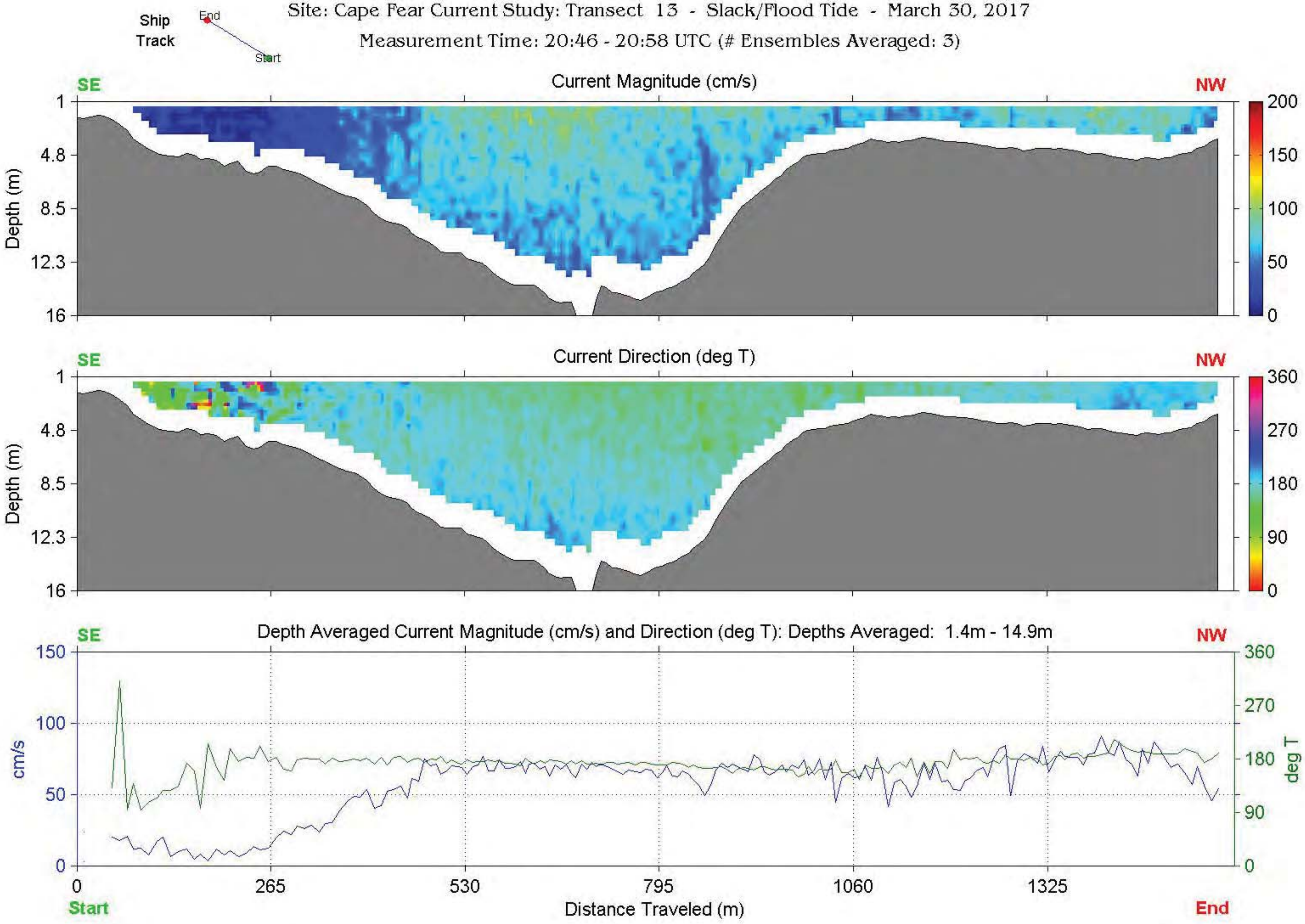
Current Magnitude (cm/s)

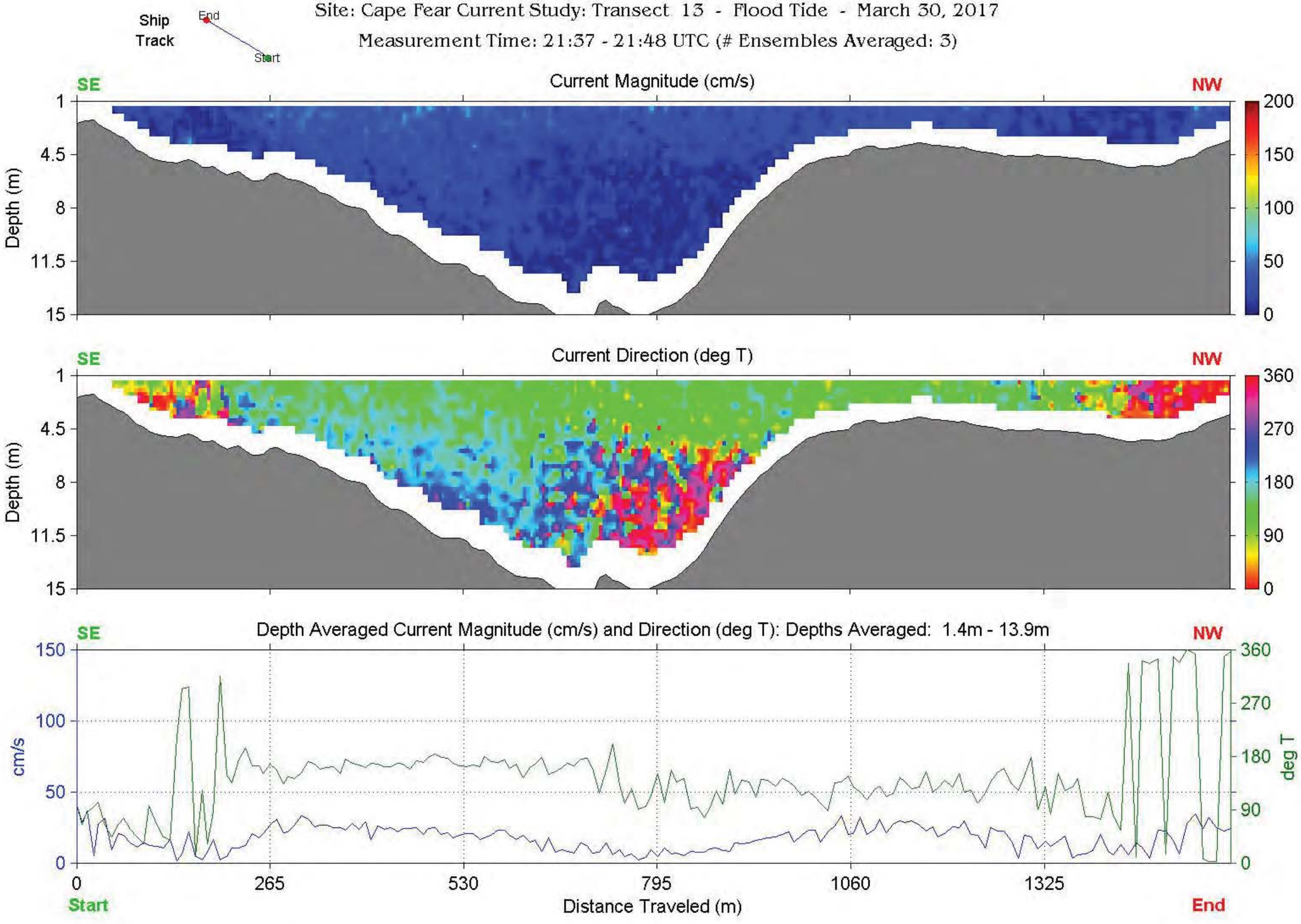
Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.4m - 13.9m

Site: Cape Fear Current Study: Transect 13 - Slack/Flood Tide - March 30, 2017

Measurement Time: 20:46 - 20:58 UTC (# Ensembles Averaged: 3)



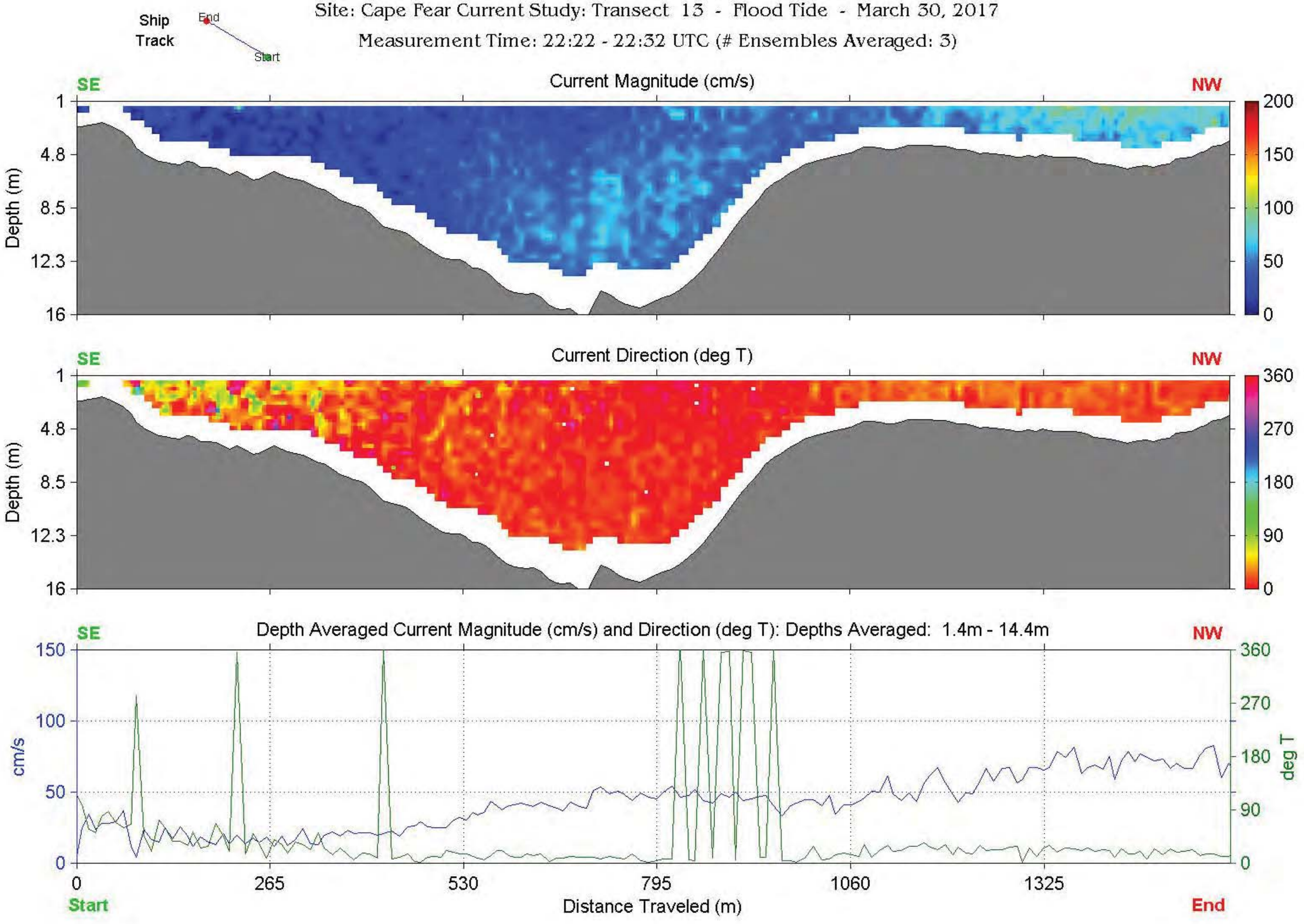


Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 30, 2017

Measurement Time: 21:37 - 21:48 UTC (# Ensembles Averaged: 3)

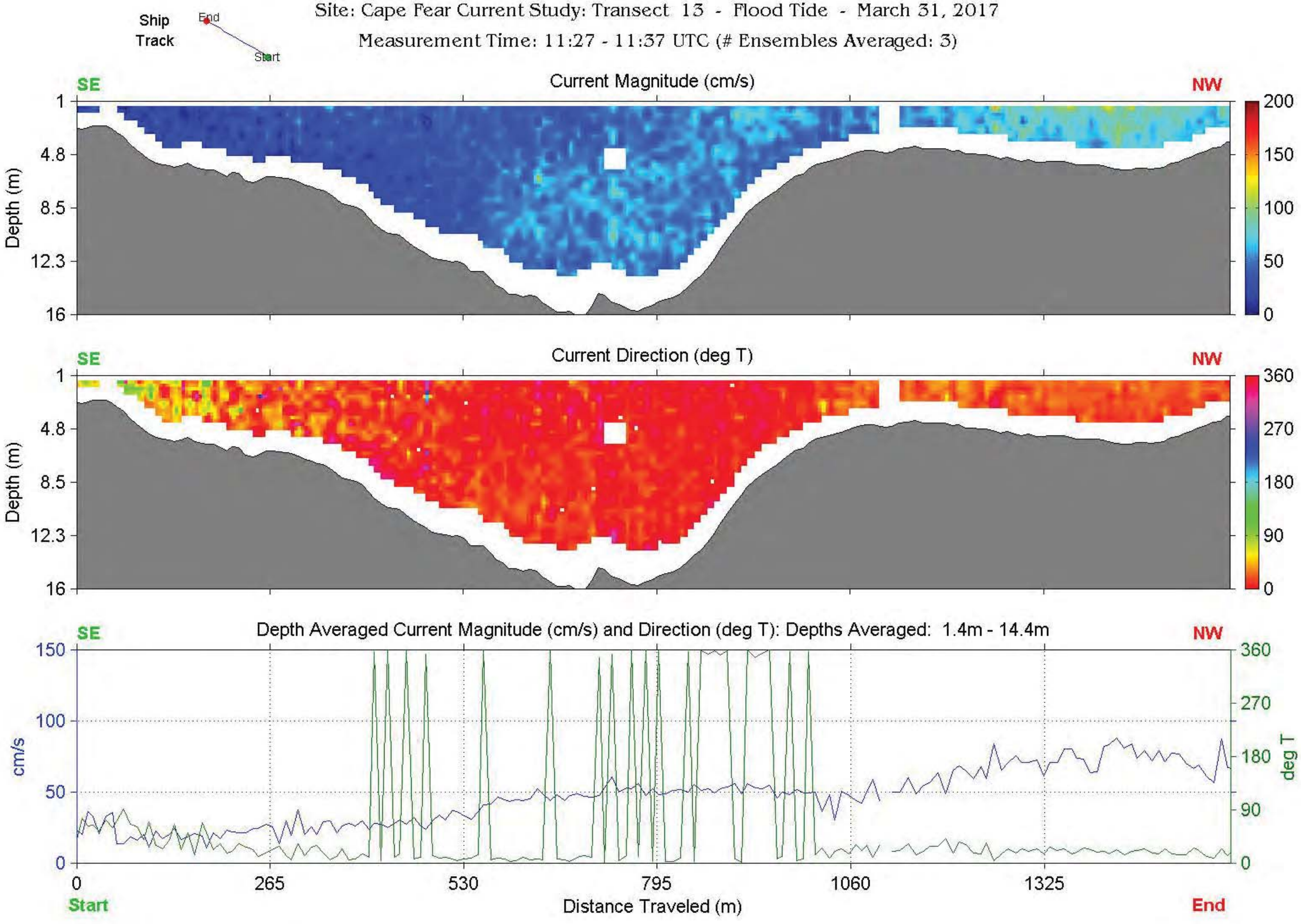
Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 30, 2017

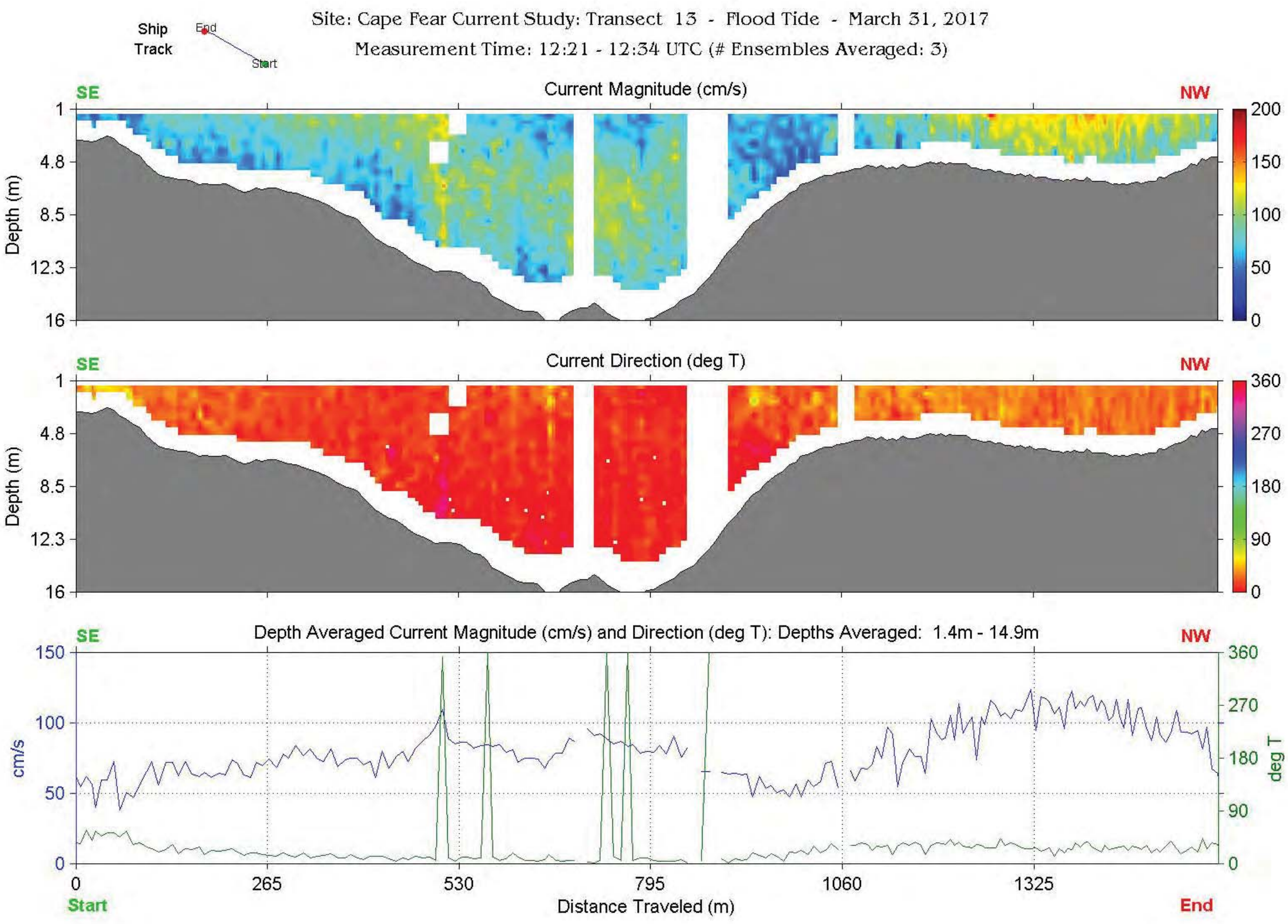
Measurement Time: 22:22 - 22:32 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 31, 2017

Measurement Time: 11:27 - 11:37 UTC (# Ensembles Averaged: 3)





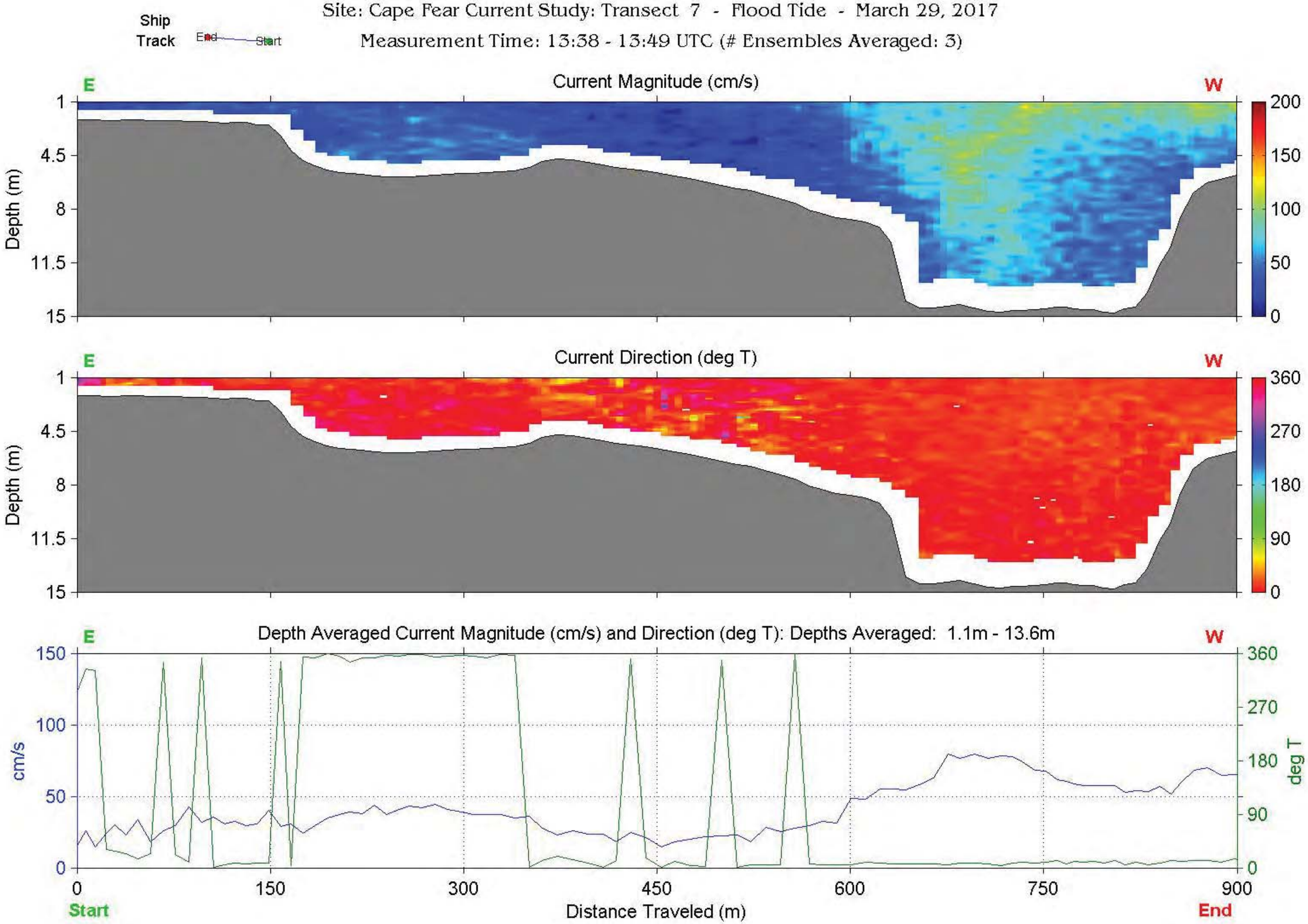
Site: Cape Fear Current Study: Transect 13 - Flood Tide - March 31, 2017

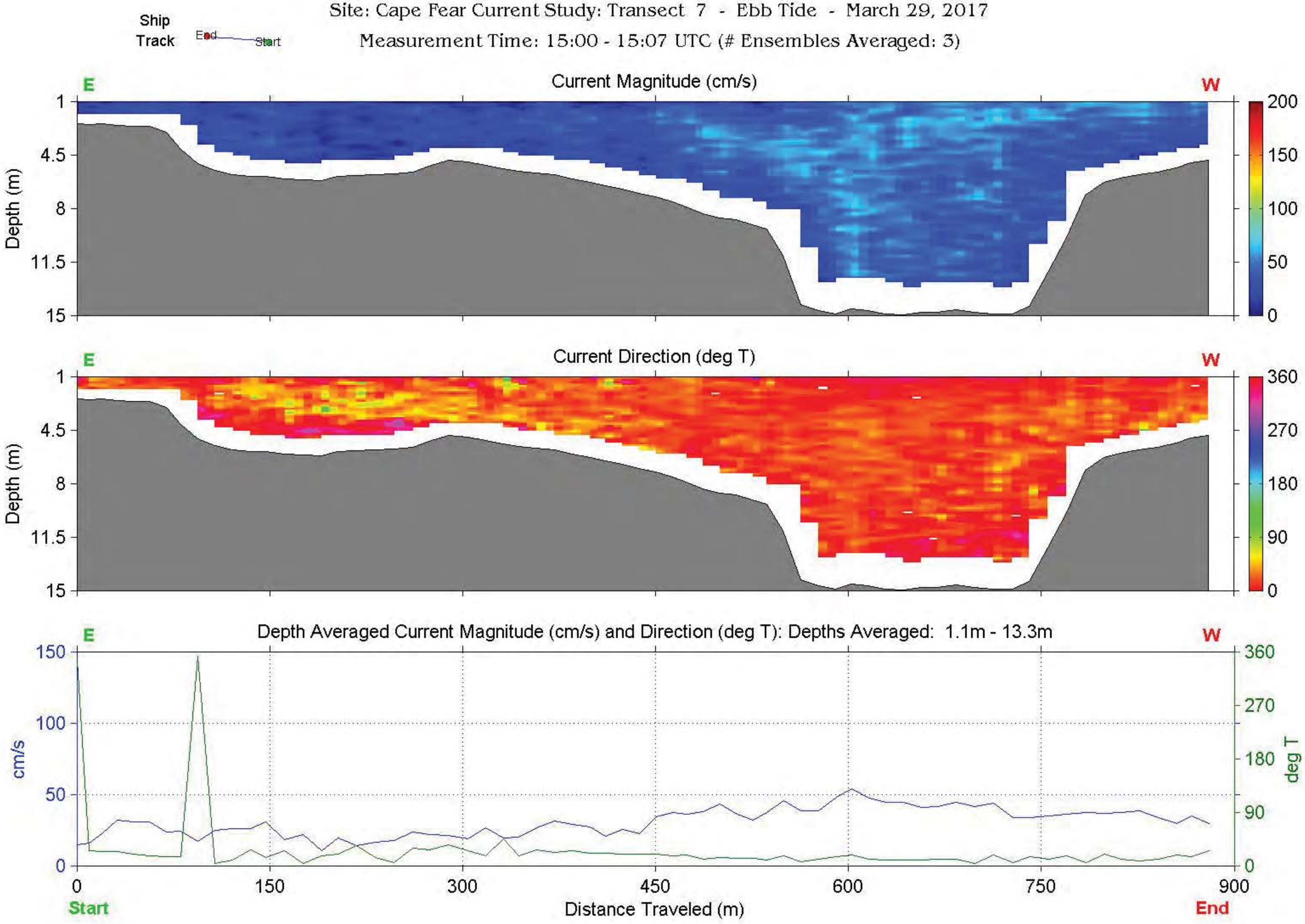
Measurement Time: 12:21 - 12:34 UTC (# Ensembles Averaged: 3)

Snow’s Cut

Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 29, 2017

Measurement Time: 13:38 - 13:49 UTC (# Ensembles Averaged: 3)



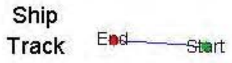


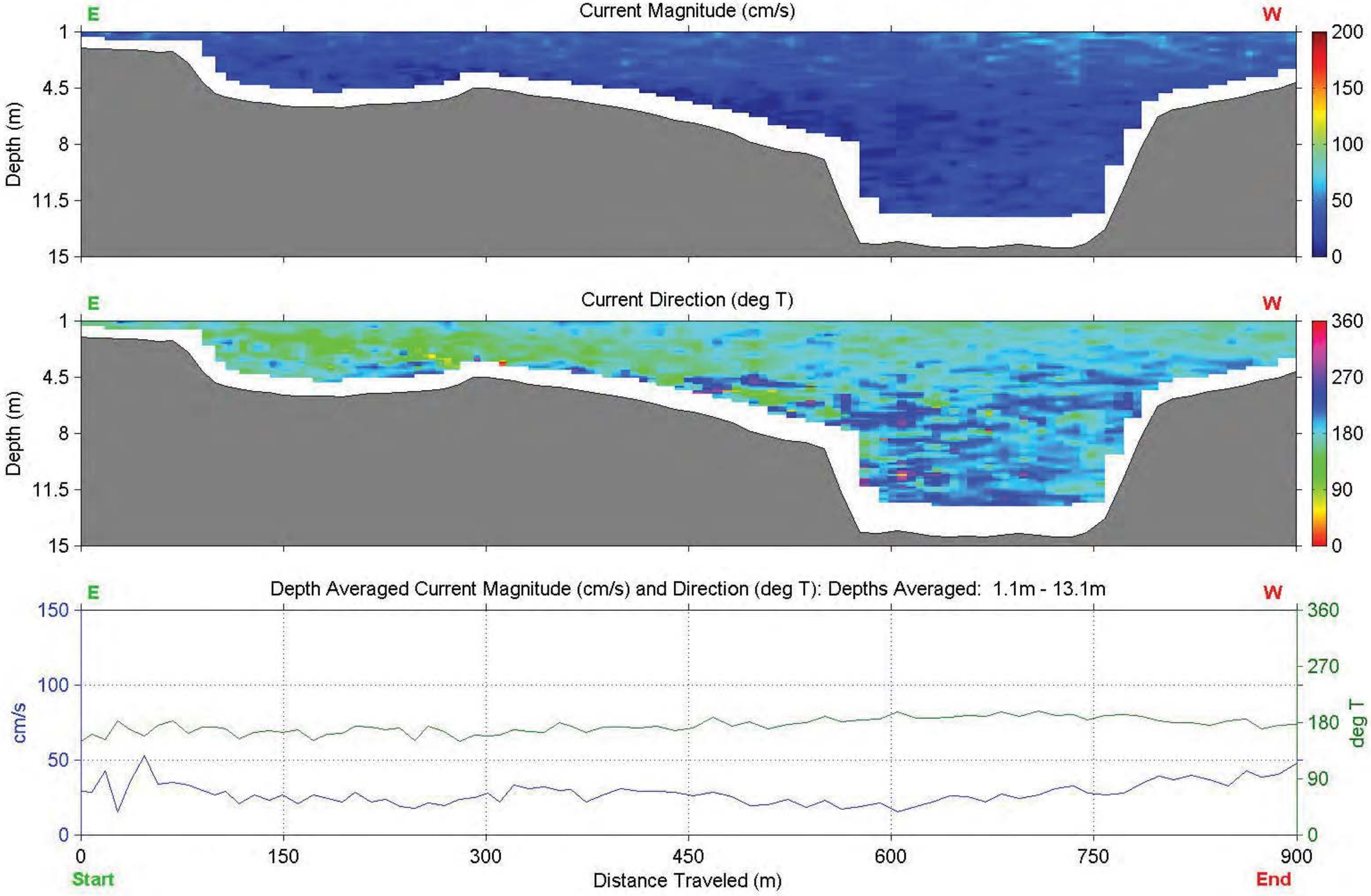
Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 29, 2017

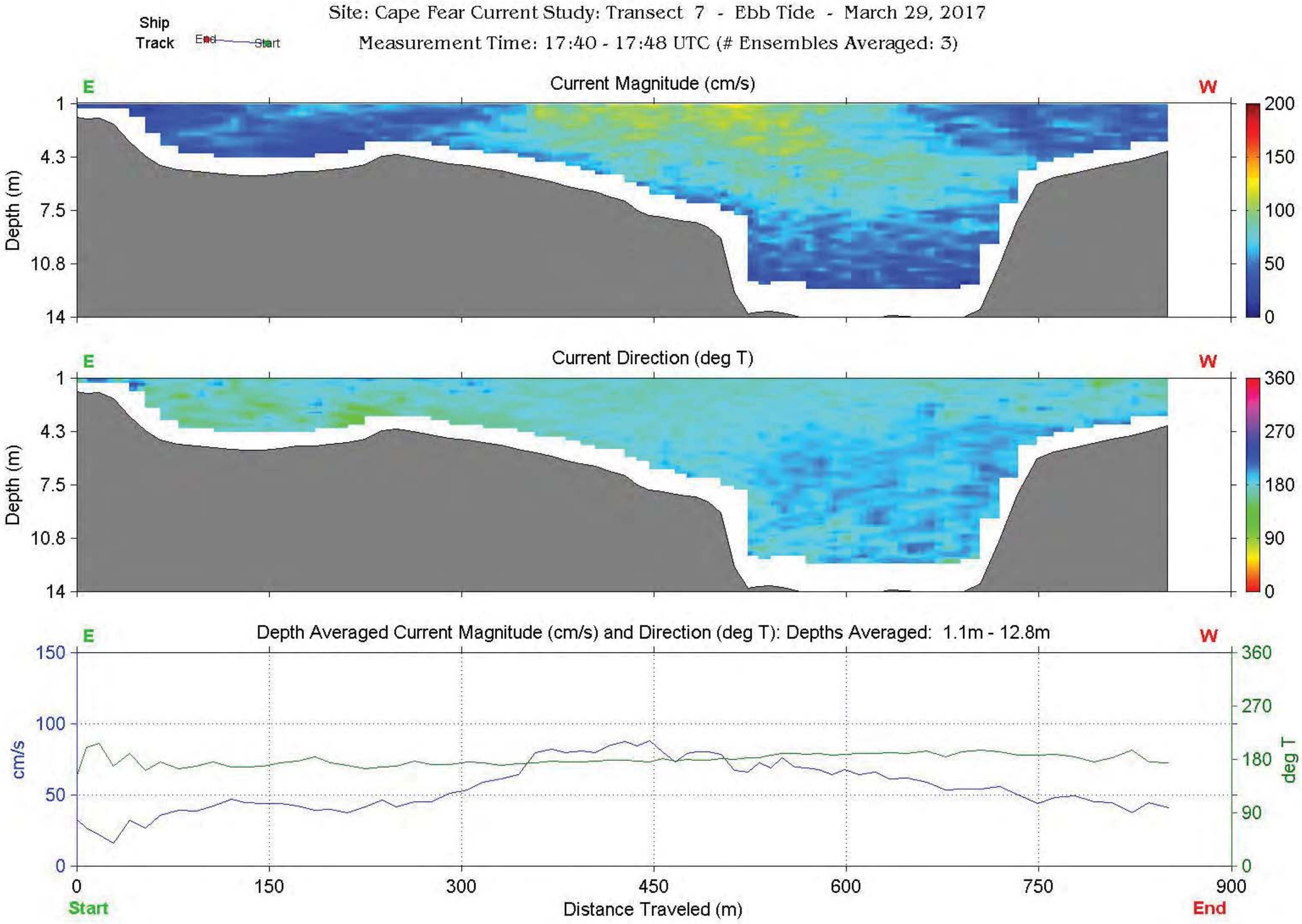
Measurement Time: 15:00 - 15:07 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 29, 2017

Measurement Time: 16:32 - 16:41 UTC (# Ensembles Averaged: 3)







Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 29, 2017

Measurement Time: 17:40 - 17:48 UTC (# Ensembles Averaged: 3)

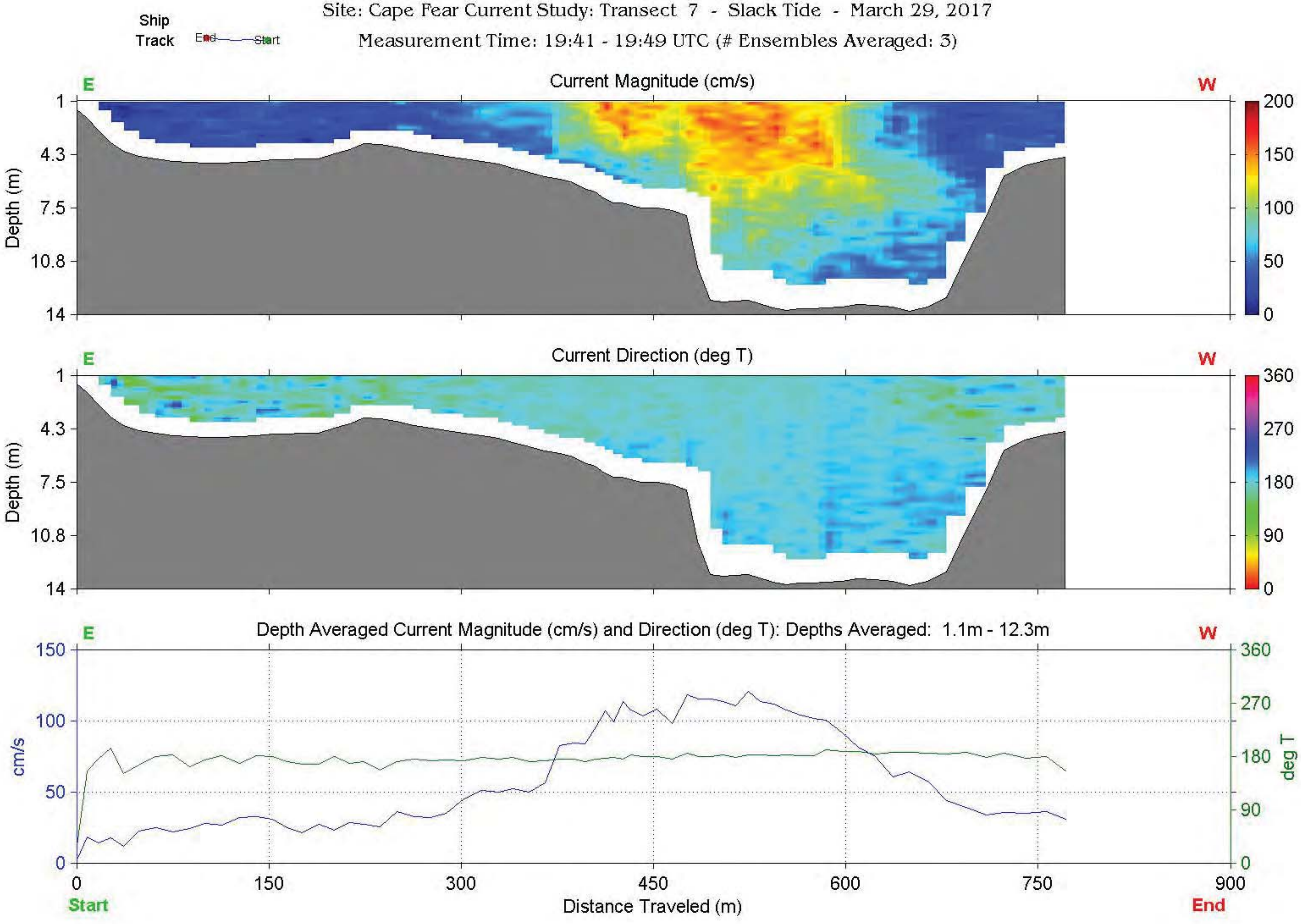
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.1m - 12.8m

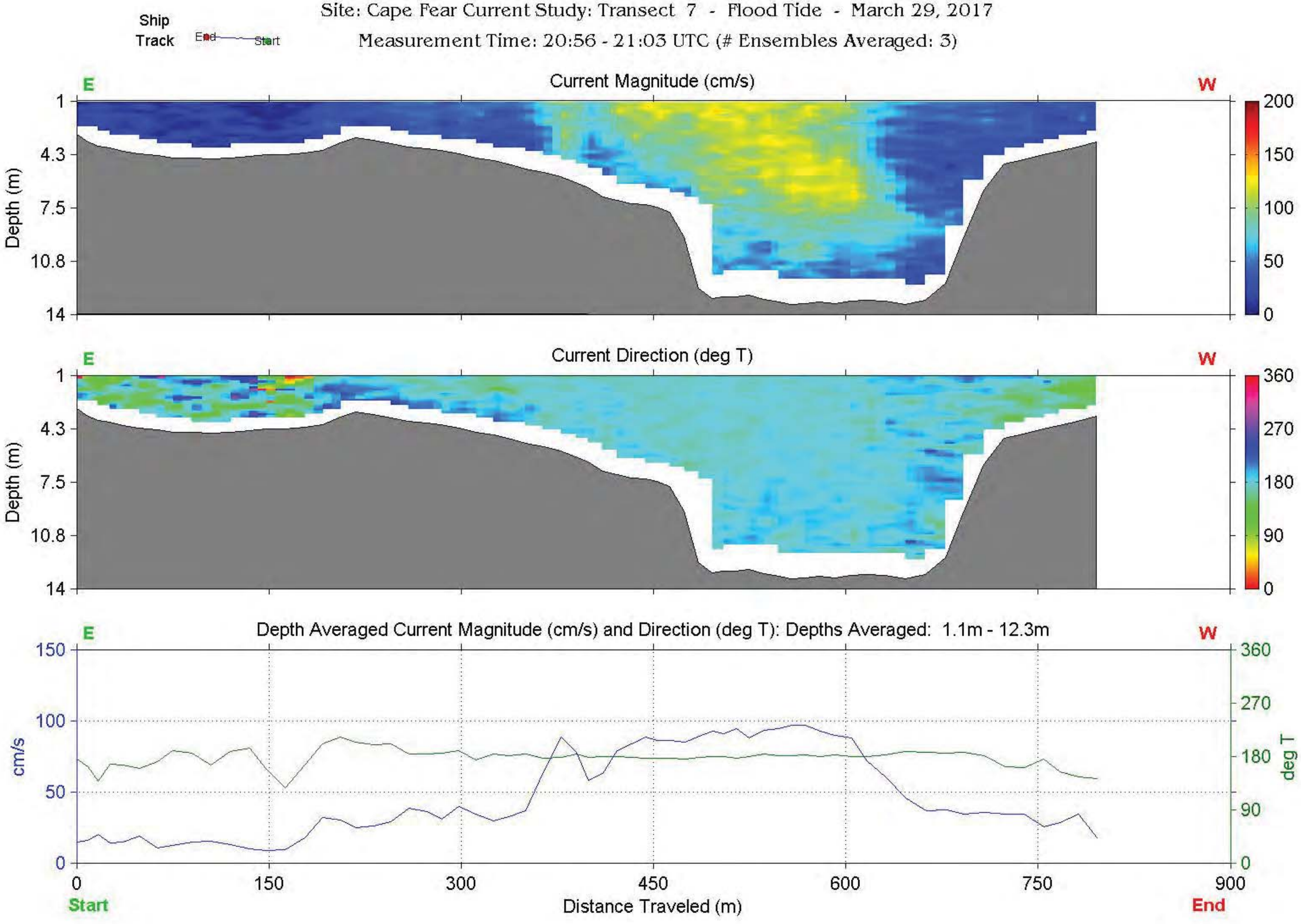
Site: Cape Fear Current Study: Transect 7 - Slack Tide - March 29, 2017

Measurement Time: 19:41 - 19:49 UTC (# Ensembles Averaged: 3)



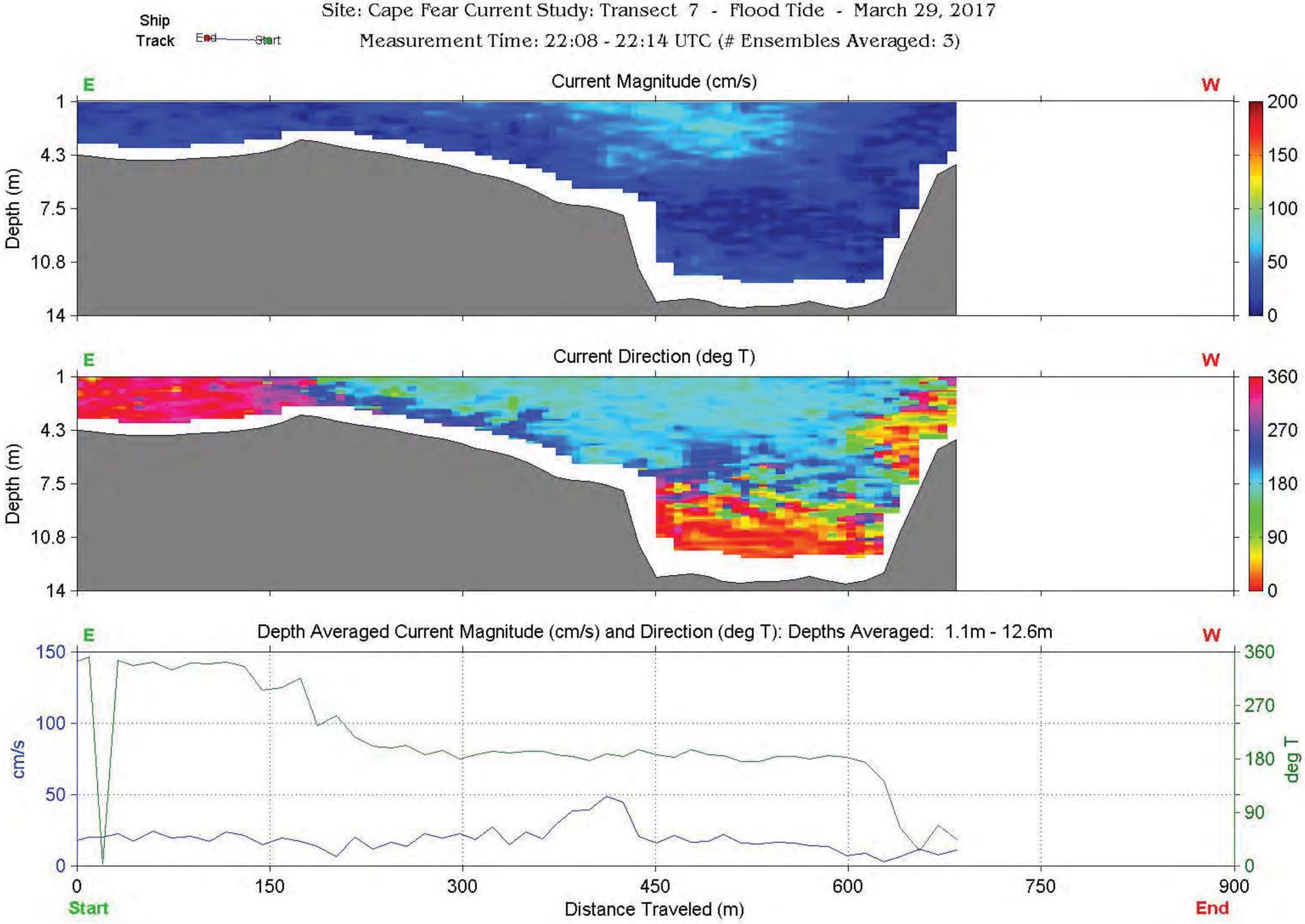
Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 29, 2017

Measurement Time: 20:56 - 21:03 UTC (# Ensembles Averaged: 3)



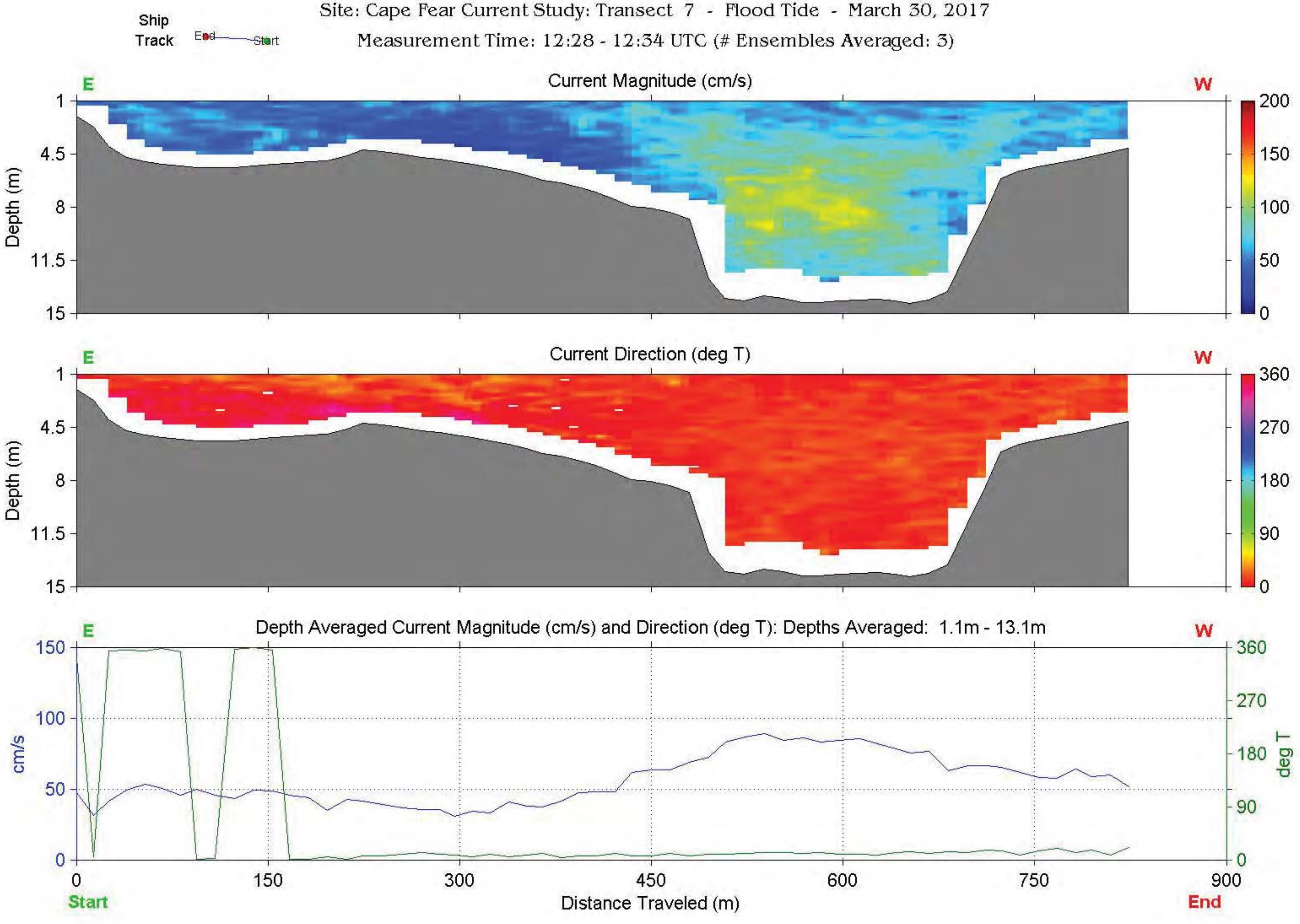
Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 29, 2017

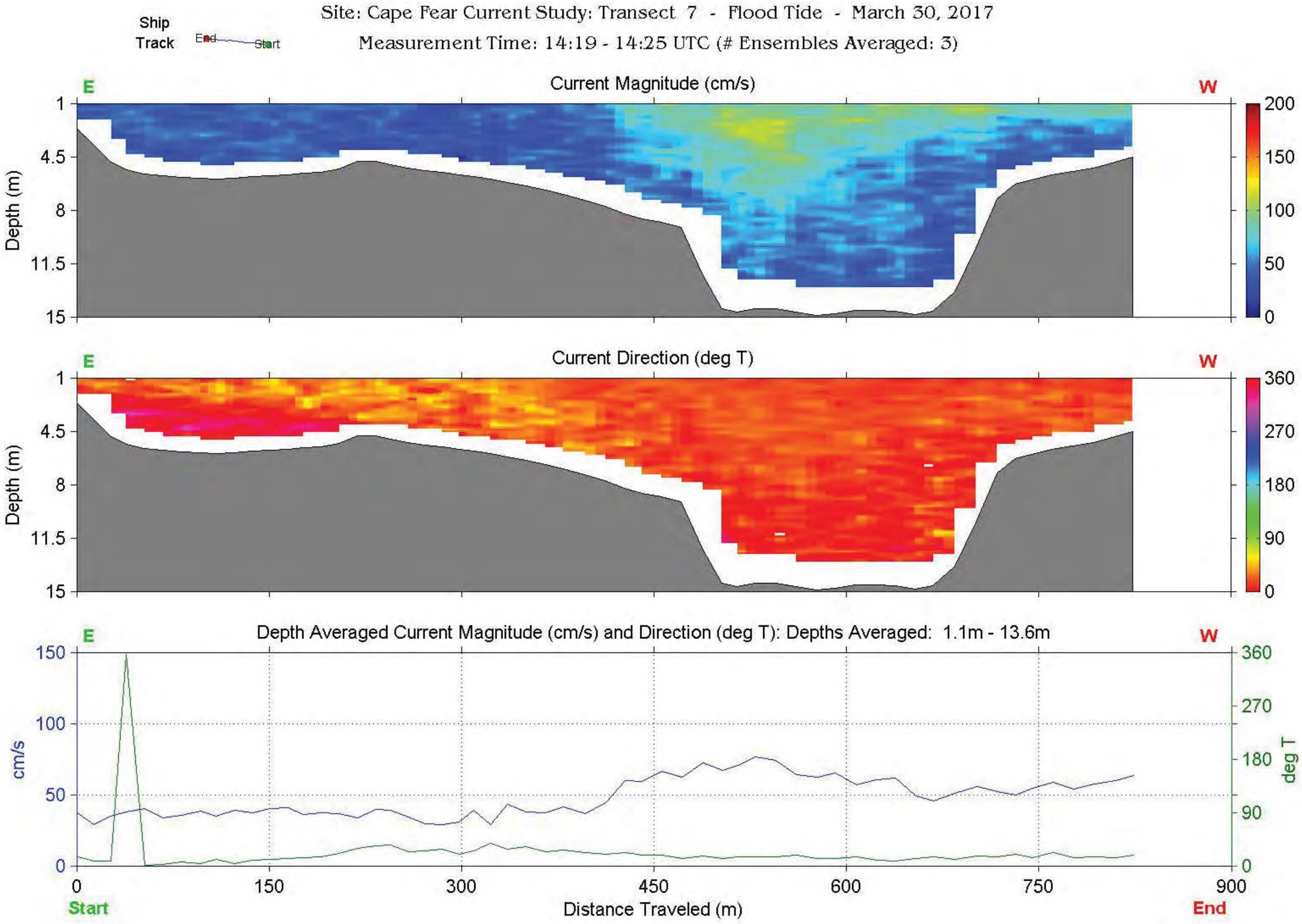
Measurement Time: 22:08 - 22:14 UTC (# Ensembles Averaged: 3)



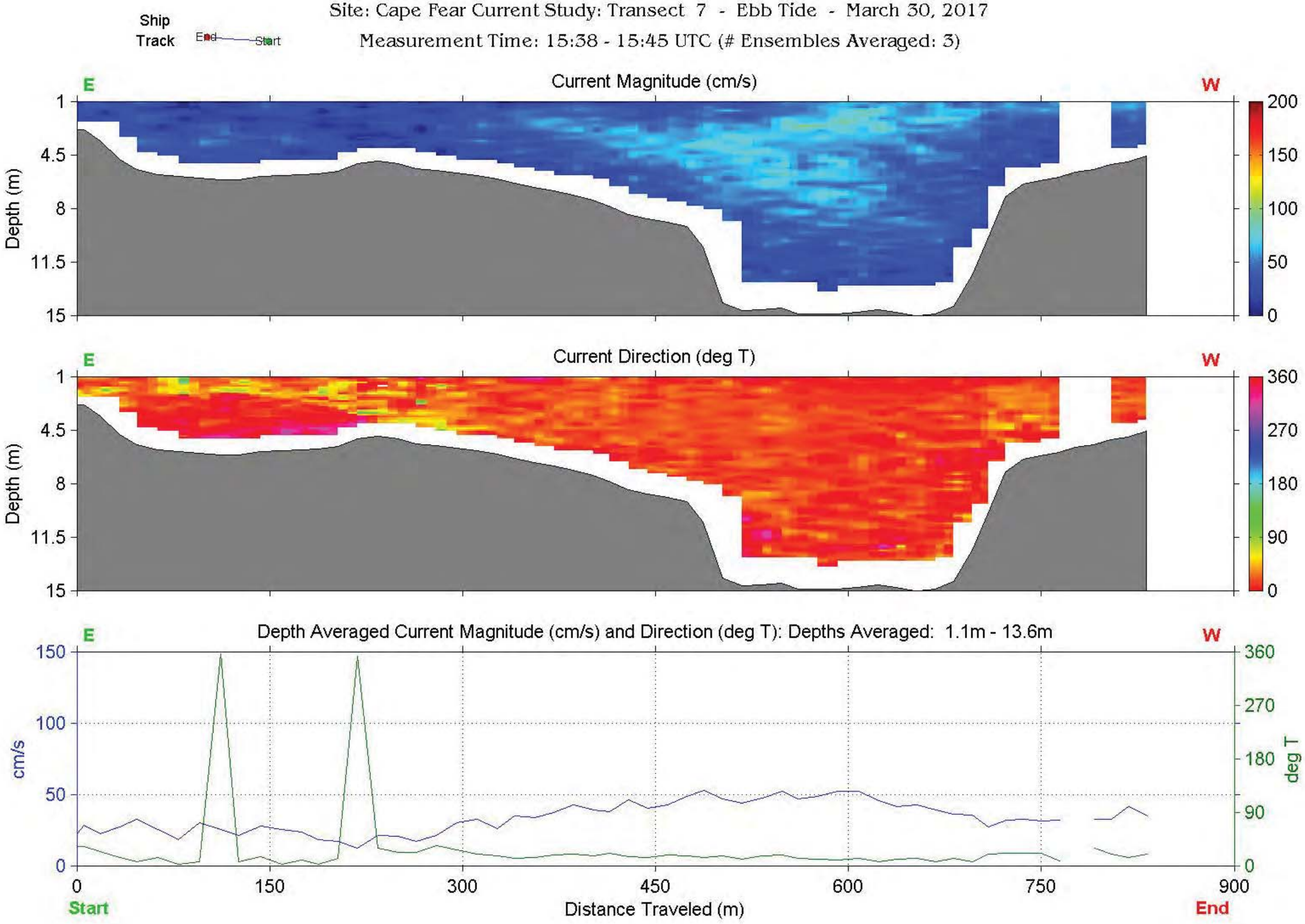
Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 30, 2017

Measurement Time: 12:28 - 12:34 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 30, 2017

Measurement Time: 14:19 - 14:25 UTC (# Ensembles Averaged: 3)

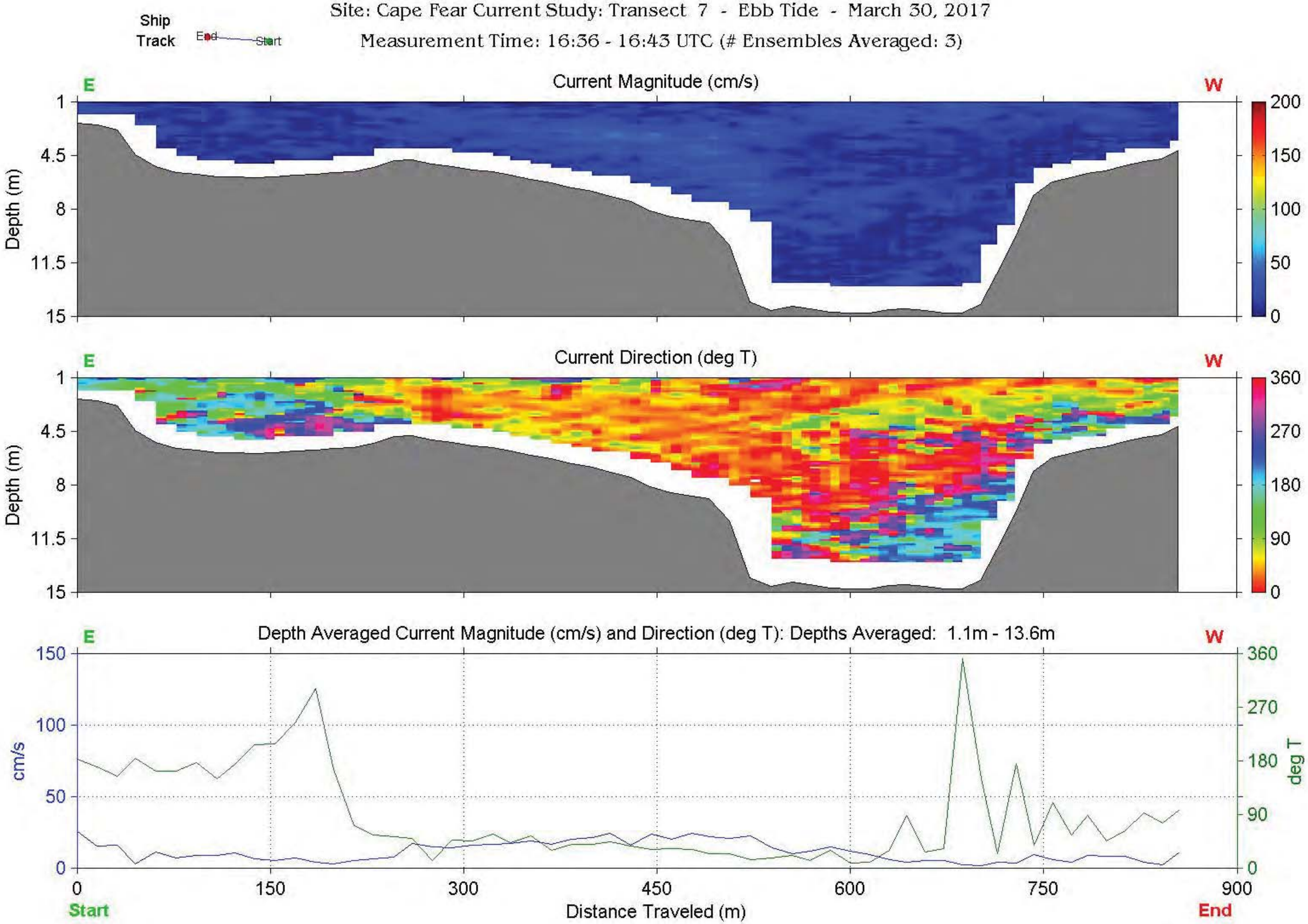


Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 30, 2017

Measurement Time: 15:38 - 15:45 UTC (# Ensembles Averaged: 3)

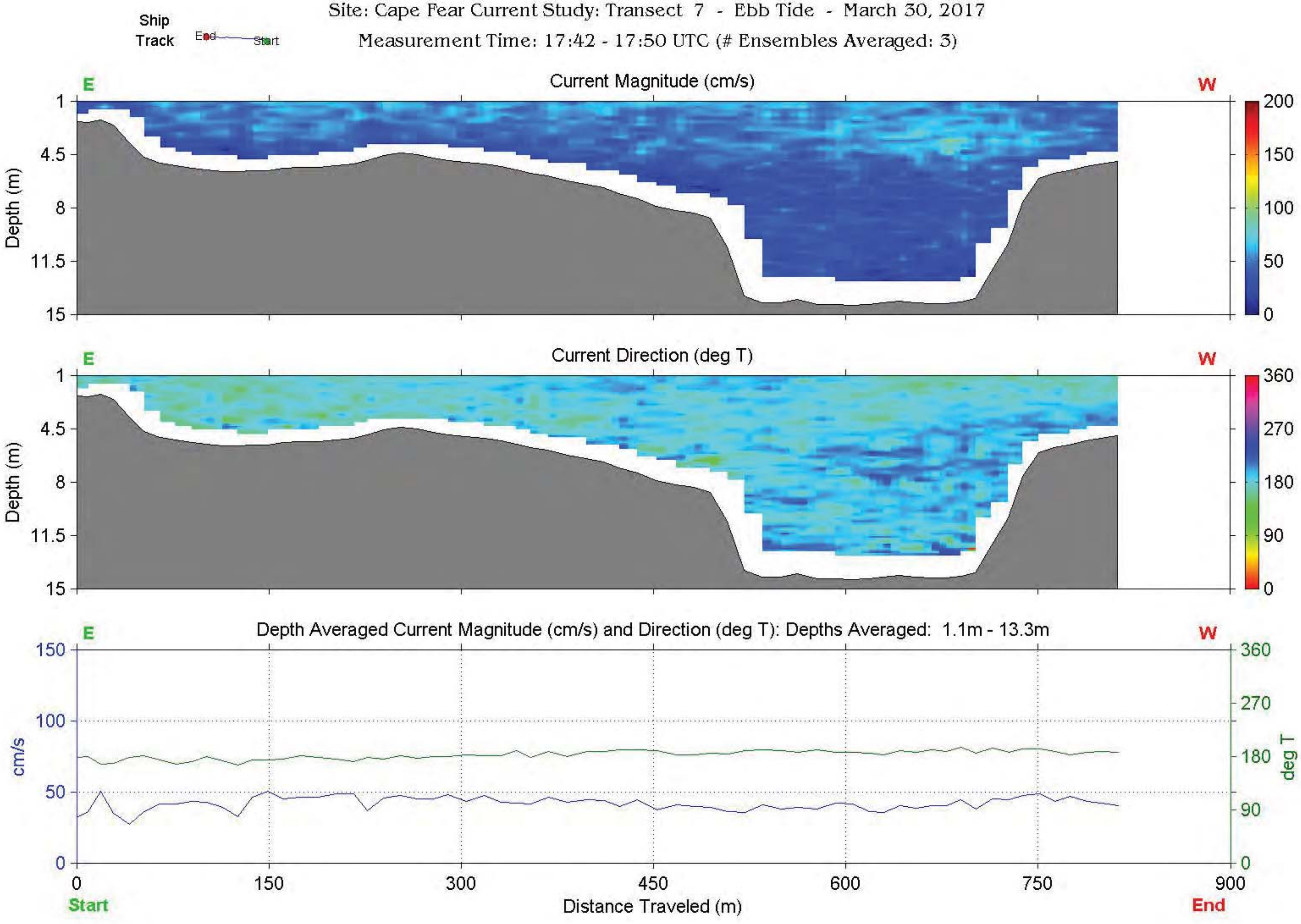
Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 30, 2017

Measurement Time: 16:36 - 16:43 UTC (# Ensembles Averaged: 3)



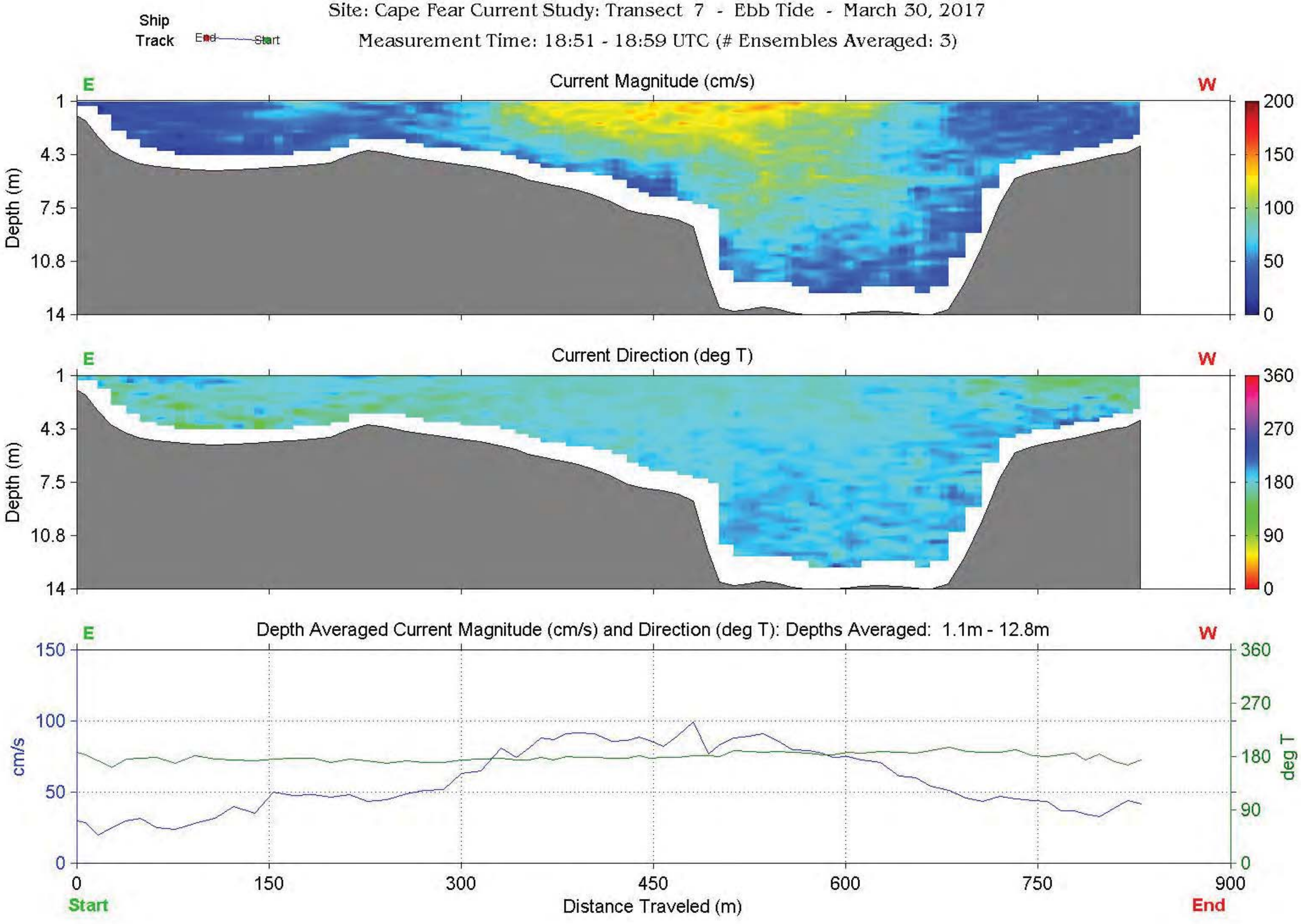
Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 30, 2017

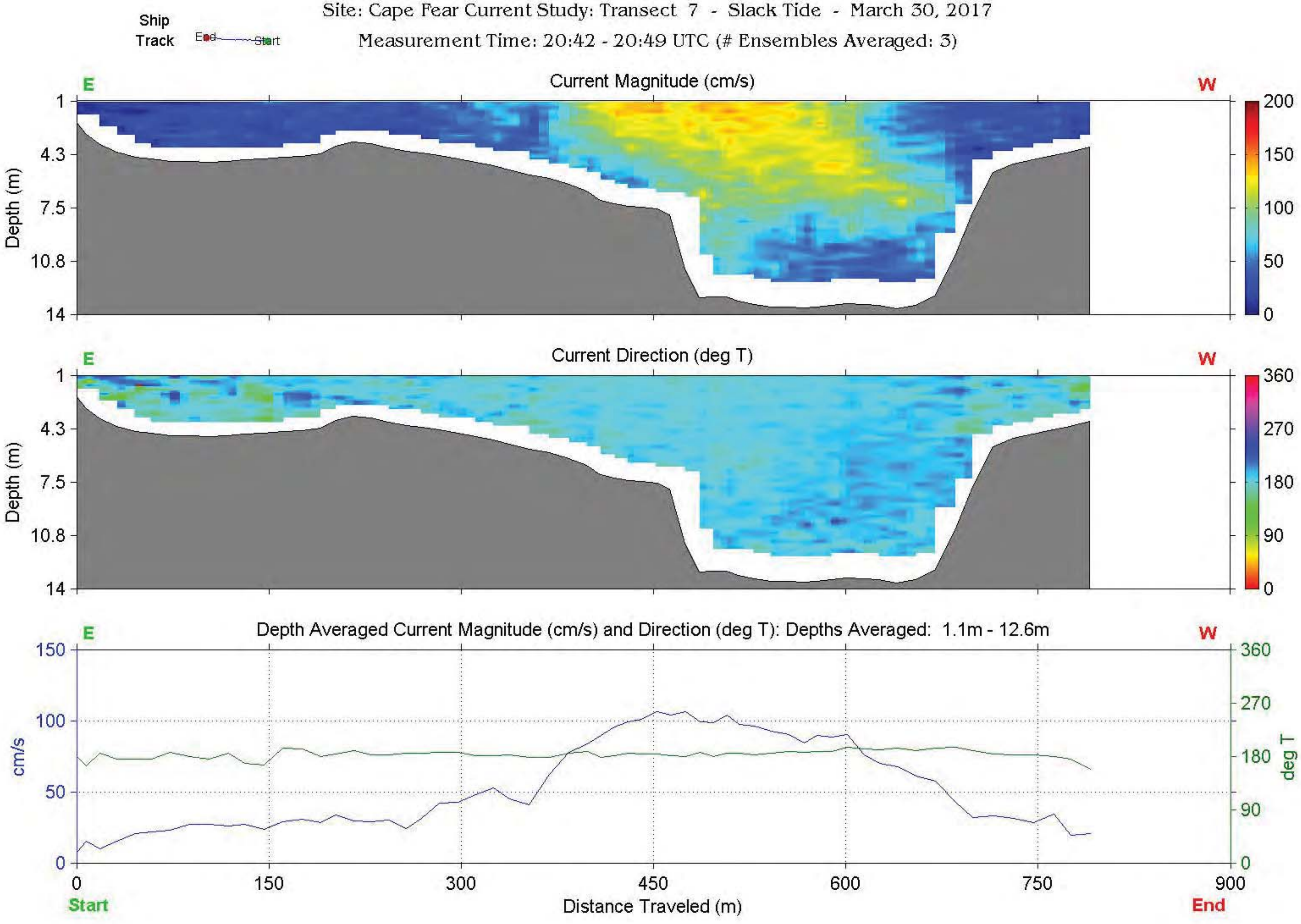
Measurement Time: 17:42 - 17:50 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 30, 2017

Measurement Time: 18:51 - 18:59 UTC (# Ensembles Averaged: 3)



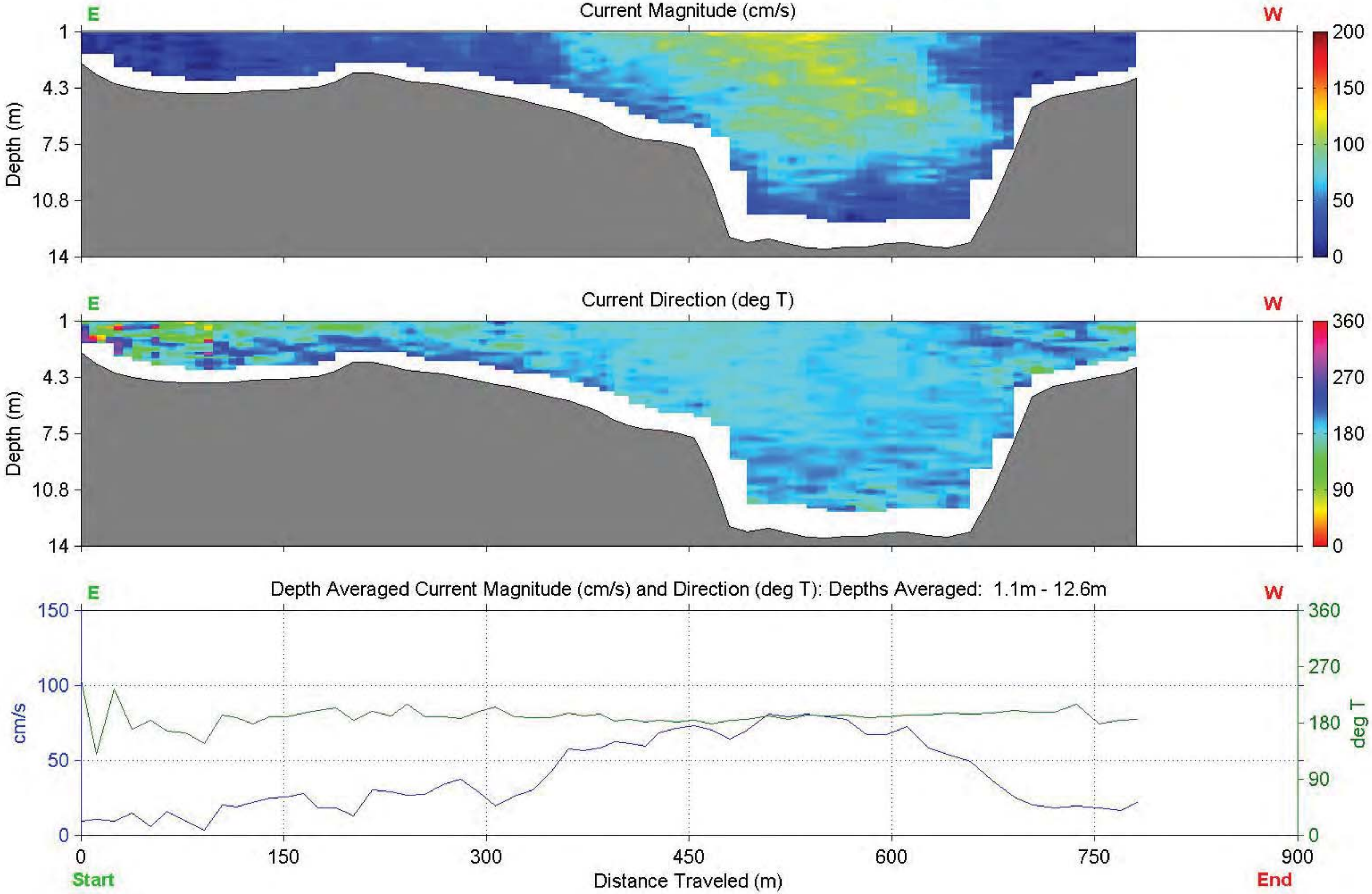


Site: Cape Fear Current Study: Transect 7 - Slack Tide - March 30, 2017

Measurement Time: 20:42 - 20:49 UTC (# Ensembles Averaged: 3)

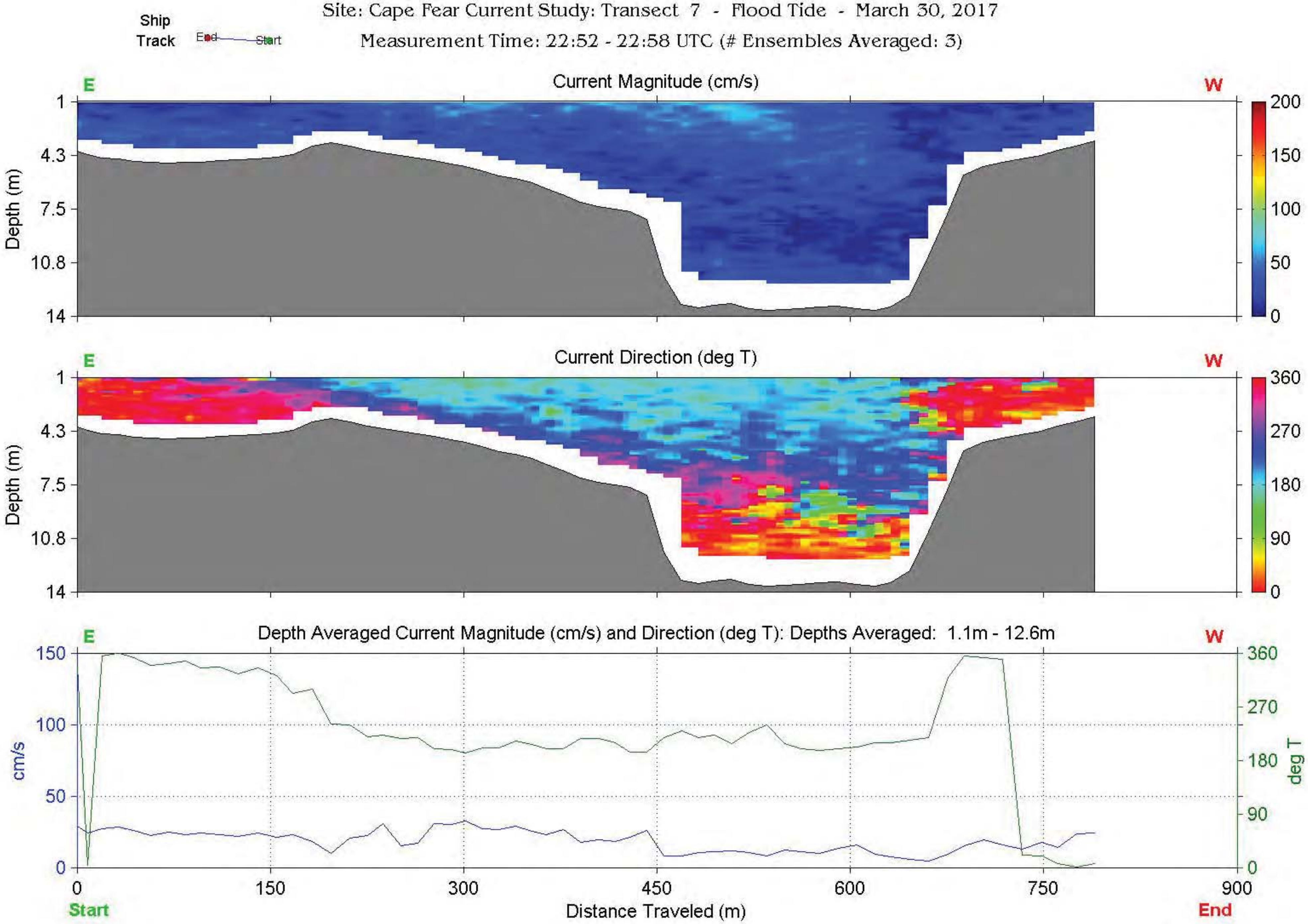
Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 30, 2017

Measurement Time: 21:49 - 21:55 UTC (# Ensembles Averaged: 3)



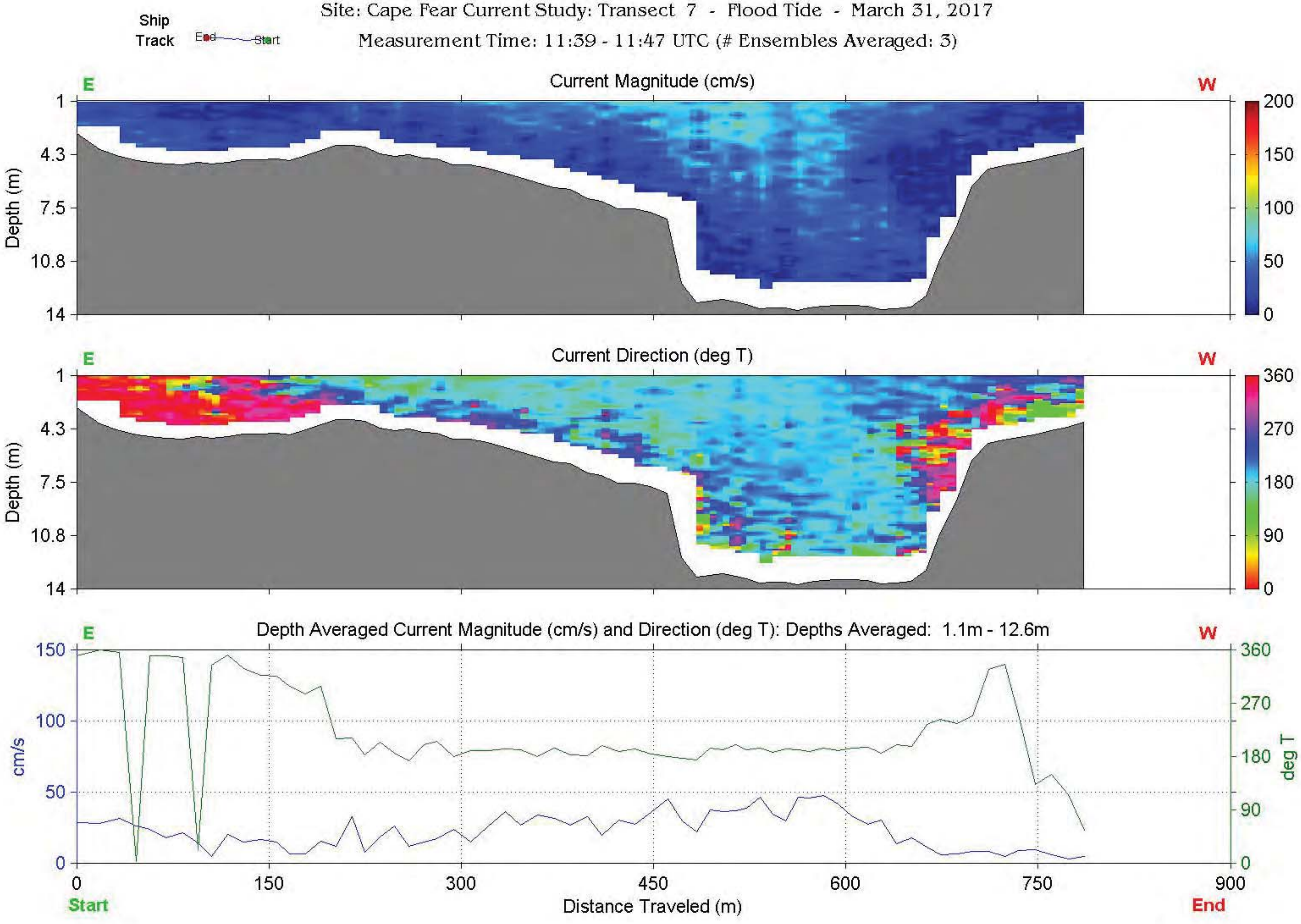
Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 30, 2017

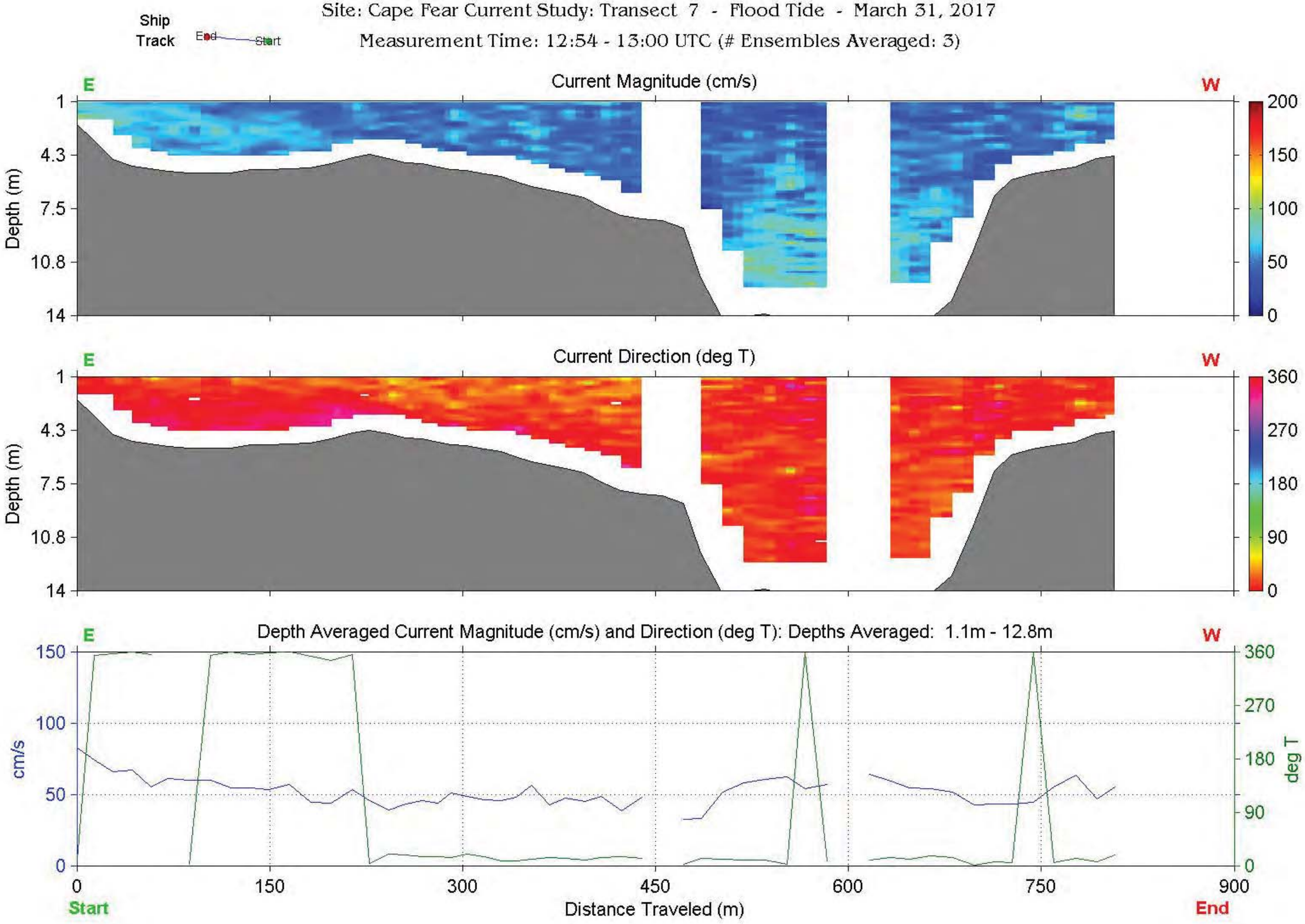
Measurement Time: 22:52 - 22:58 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 31, 2017

Measurement Time: 11:39 - 11:47 UTC (# Ensembles Averaged: 3)

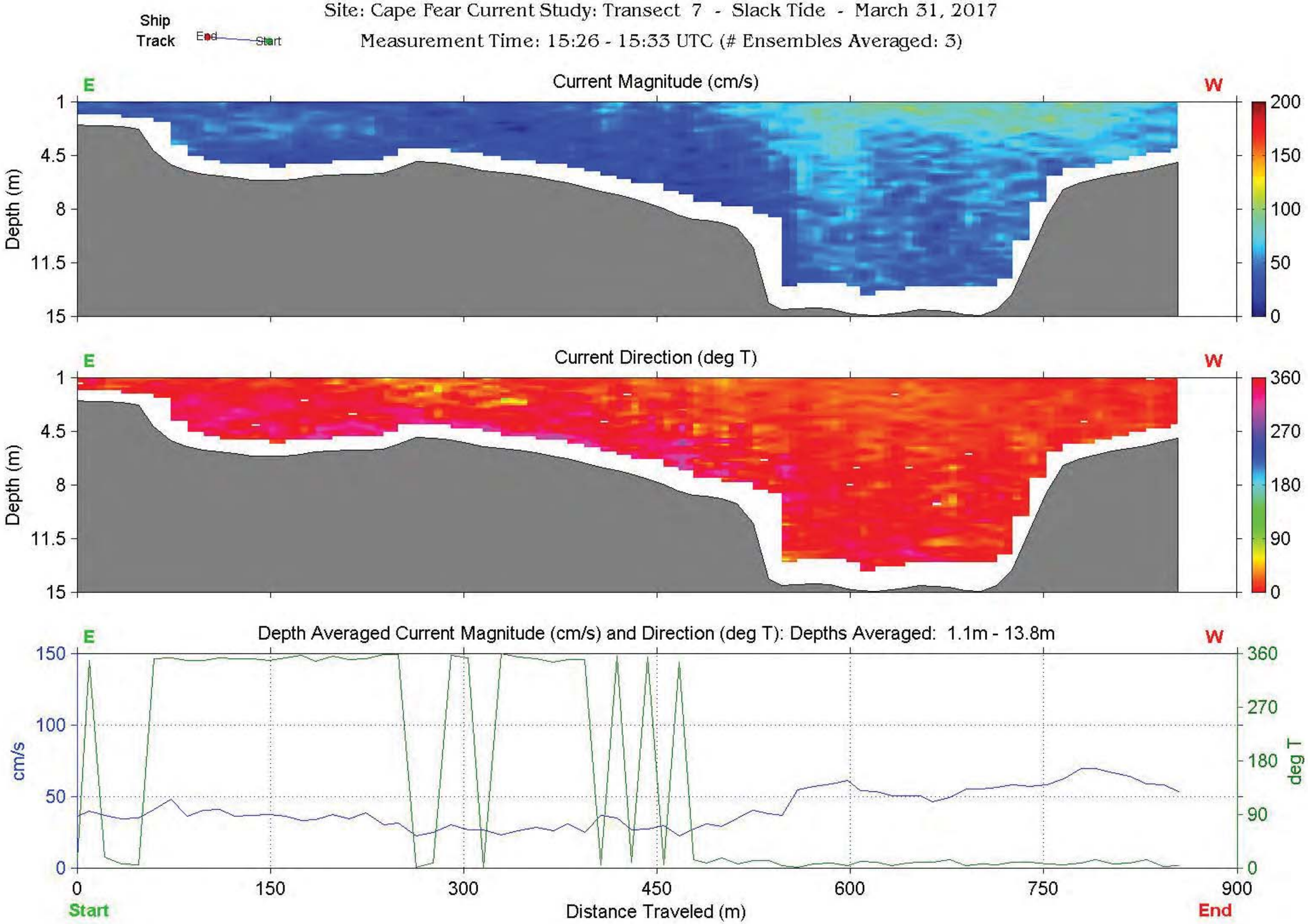



Site: Cape Fear Current Study: Transect 7 - Flood Tide - March 31, 2017

Measurement Time: 12:54 - 13:00 UTC (# Ensembles Averaged: 3)

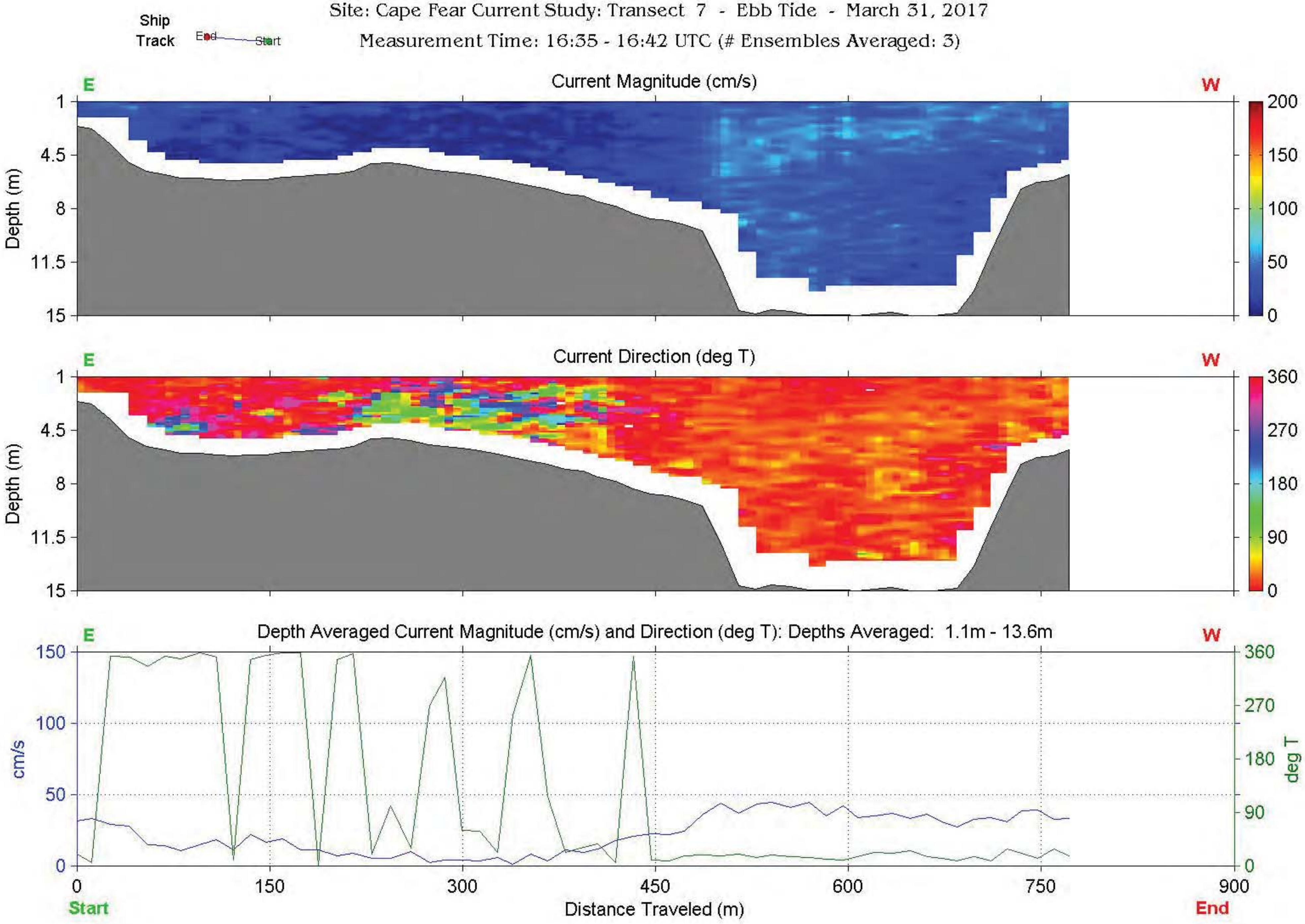
Site: Cape Fear Current Study: Transect 7 - Slack Tide - March 31, 2017

Measurement Time: 15:26 - 15:33 UTC (# Ensembles Averaged: 3)



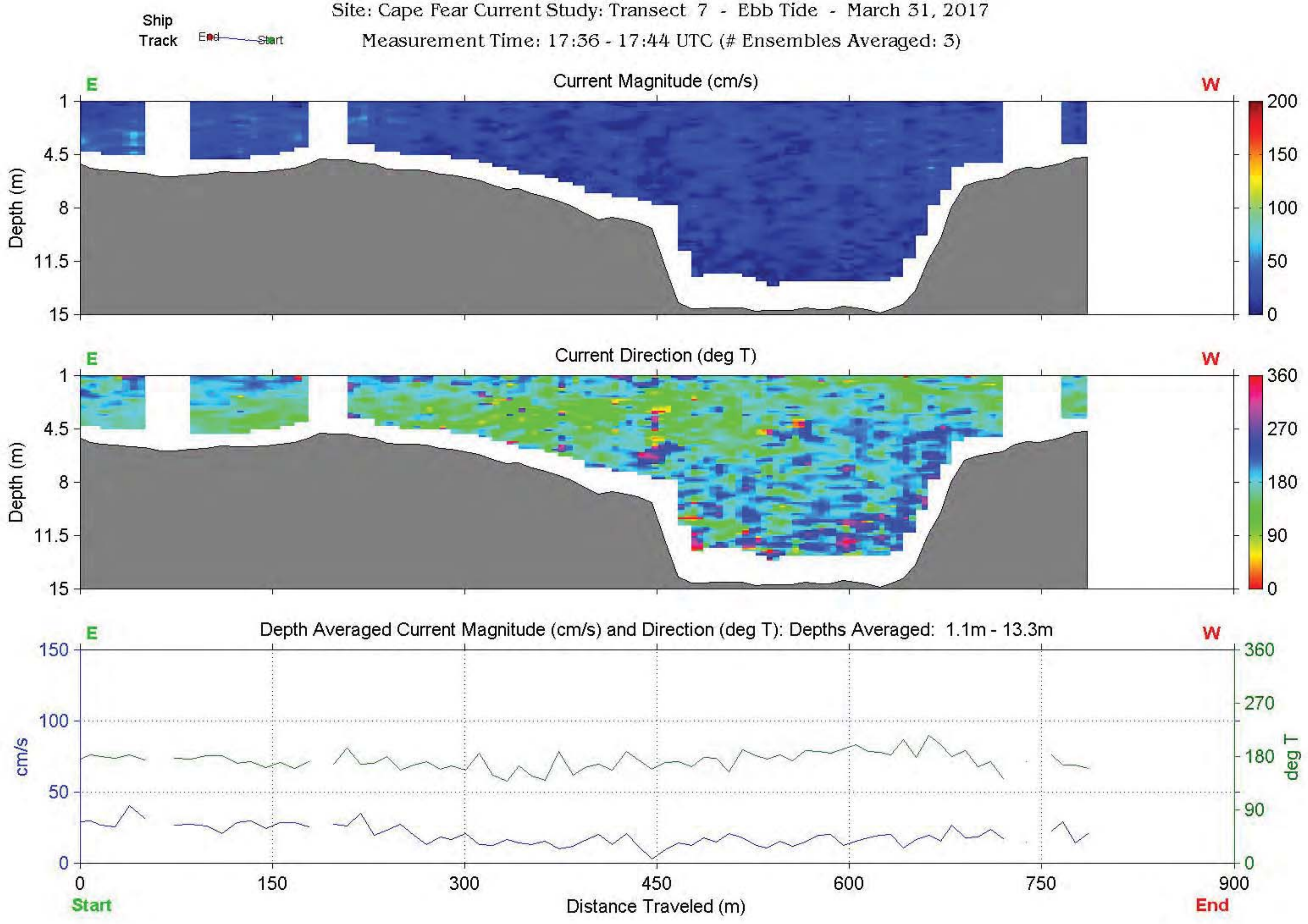
Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 31, 2017

Measurement Time: 16:35 - 16:42 UTC (# Ensembles Averaged: 3)



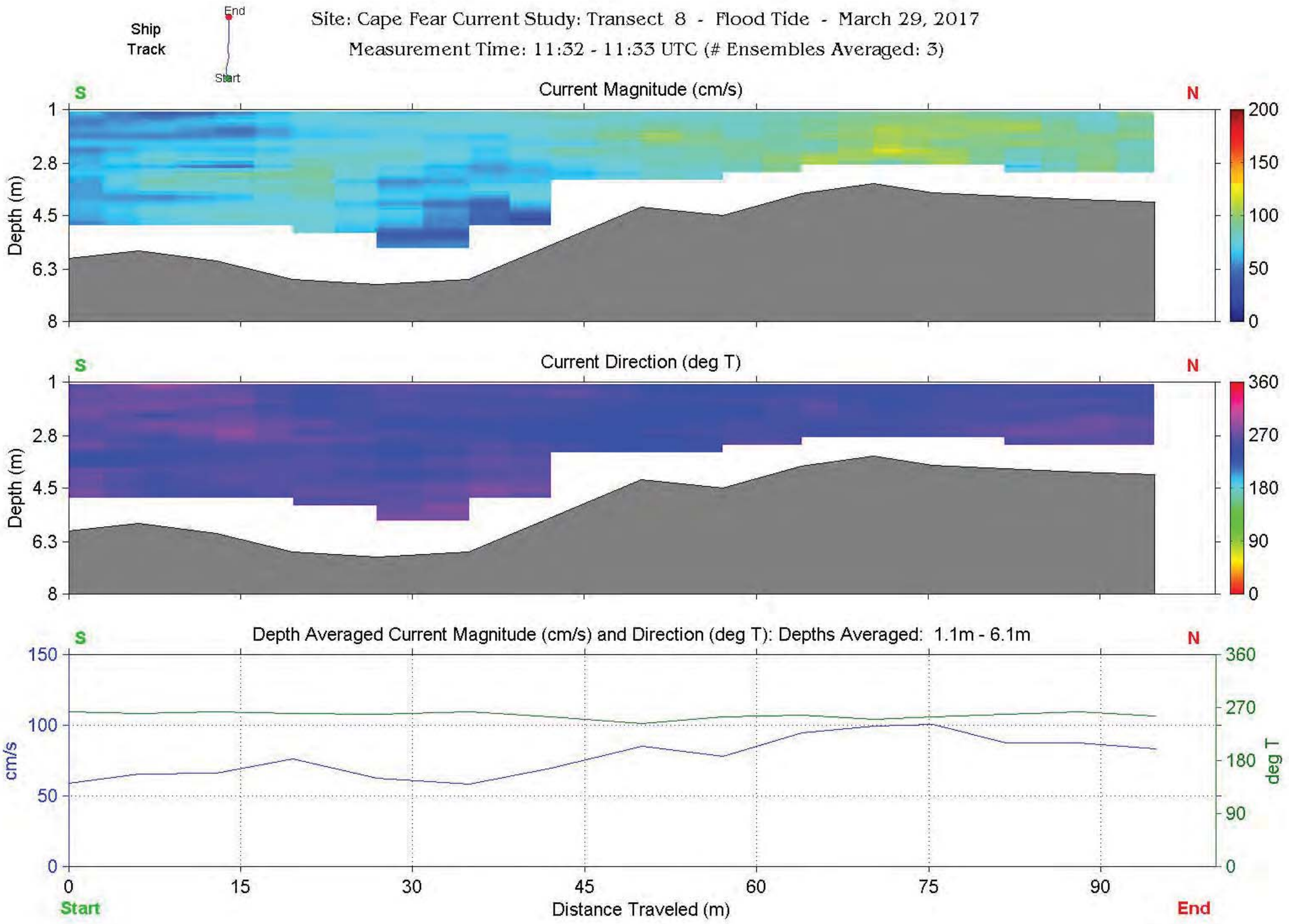
Site: Cape Fear Current Study: Transect 7 - Ebb Tide - March 31, 2017

Measurement Time: 17:36 - 17:44 UTC (# Ensembles Averaged: 3)



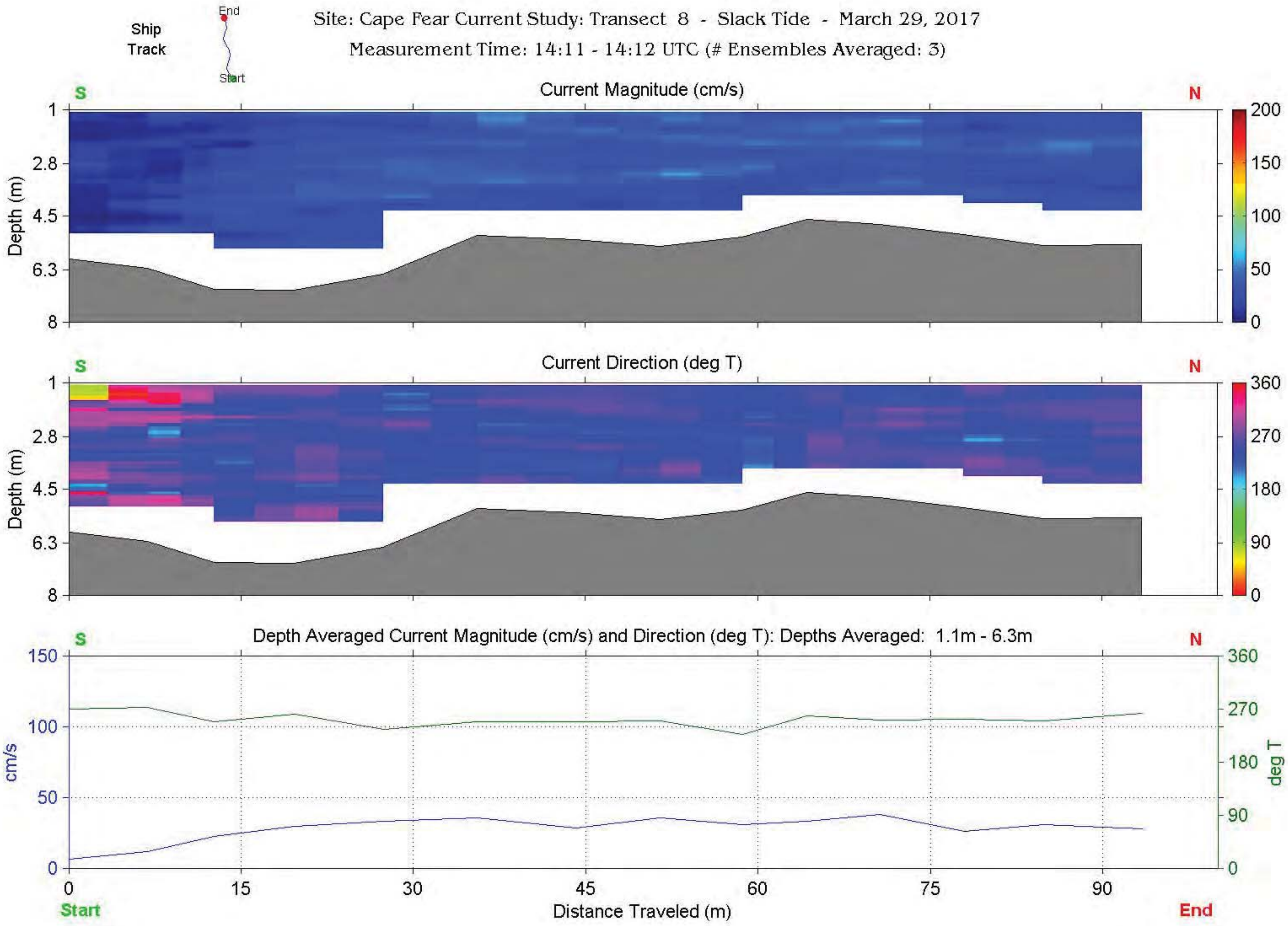
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 29, 2017

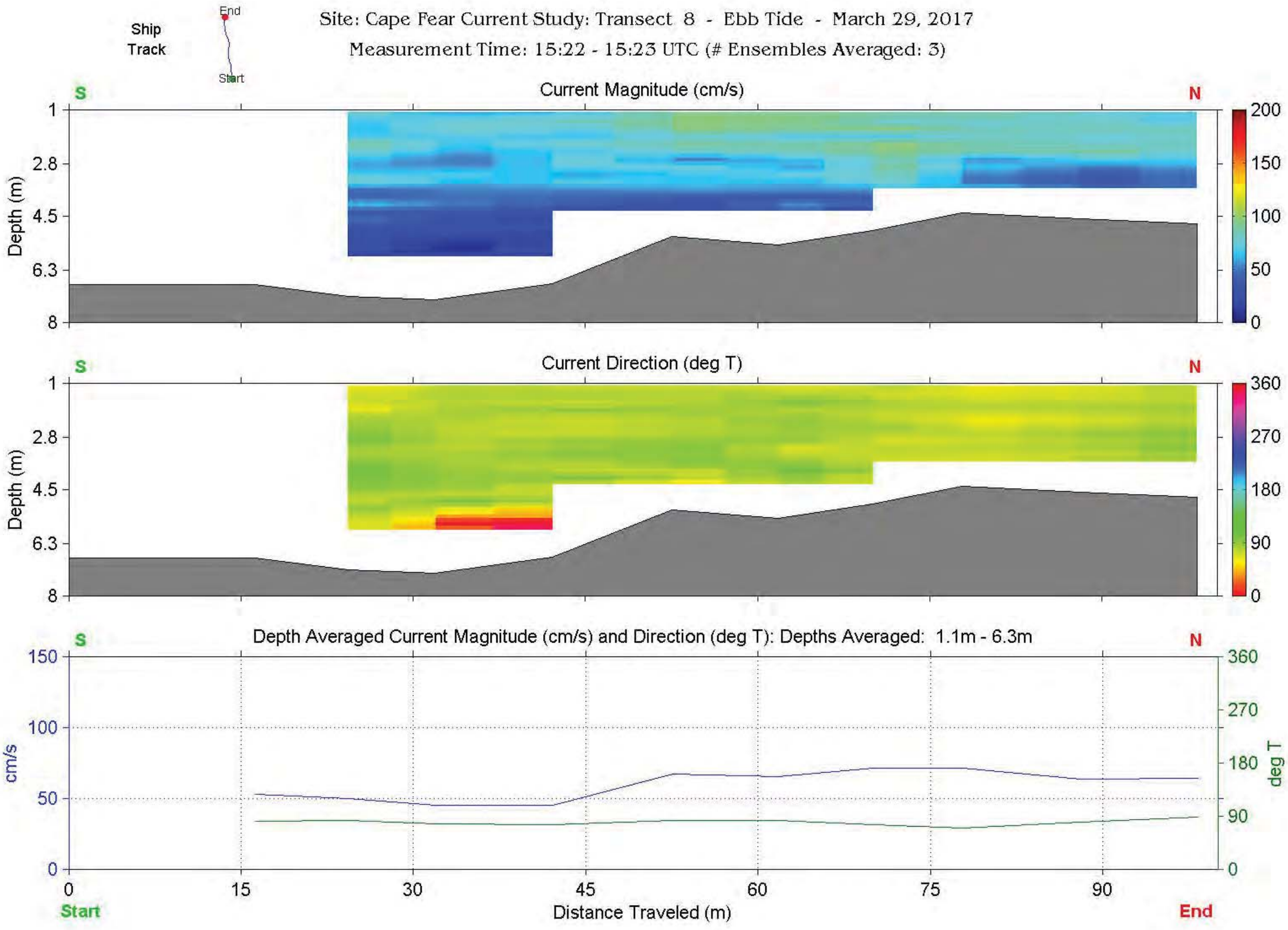
Measurement Time: 11:32 - 11:33 UTC (# Ensembles Averaged: 3)



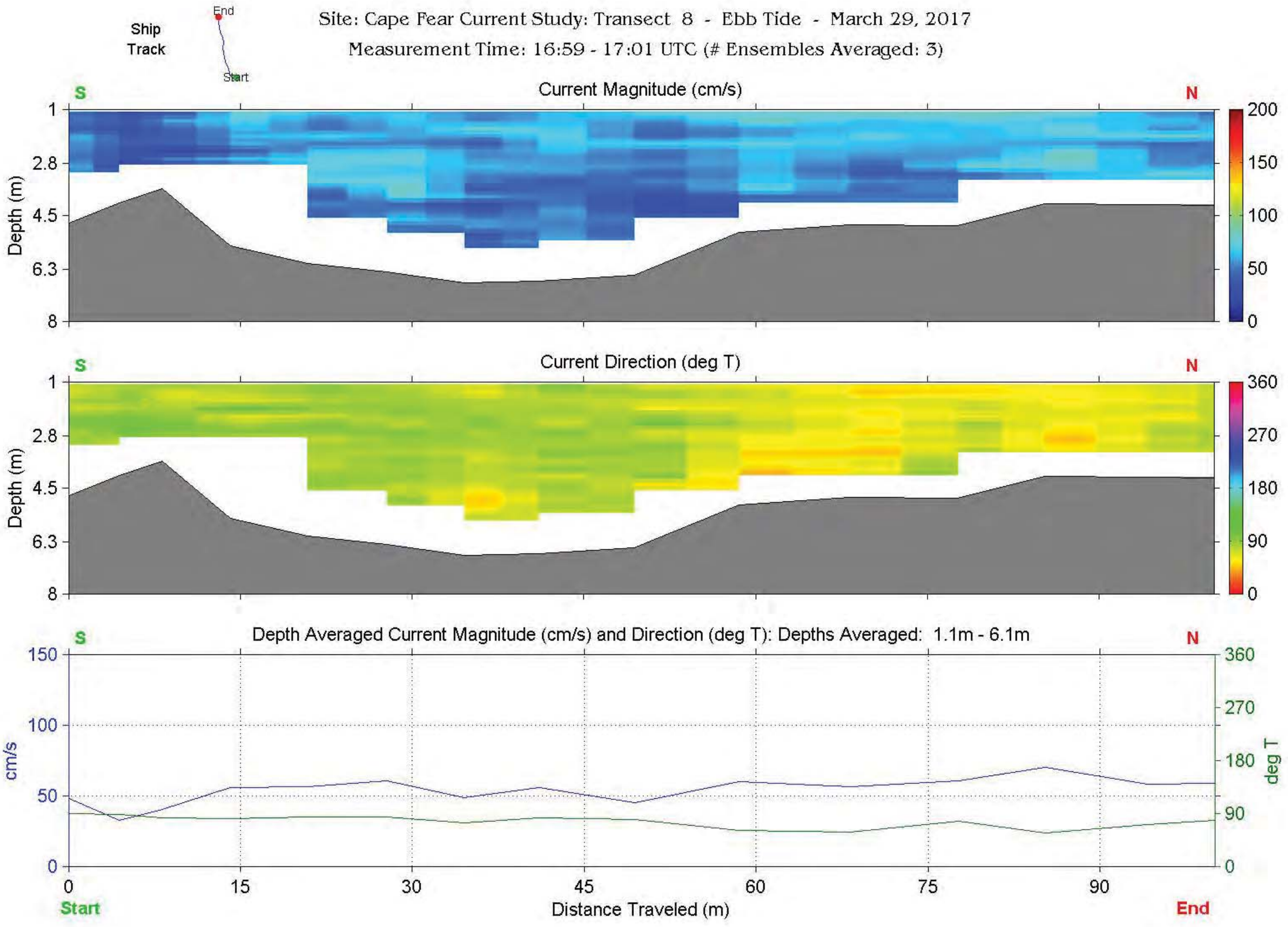
Site: Cape Fear Current Study: Transect 8 - Slack Tide - March 29, 2017

Measurement Time: 14:11 - 14:12 UTC (# Ensembles Averaged: 3)

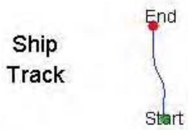



Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 29, 2017

Measurement Time: 15:22 - 15:23 UTC (# Ensembles Averaged: 3)

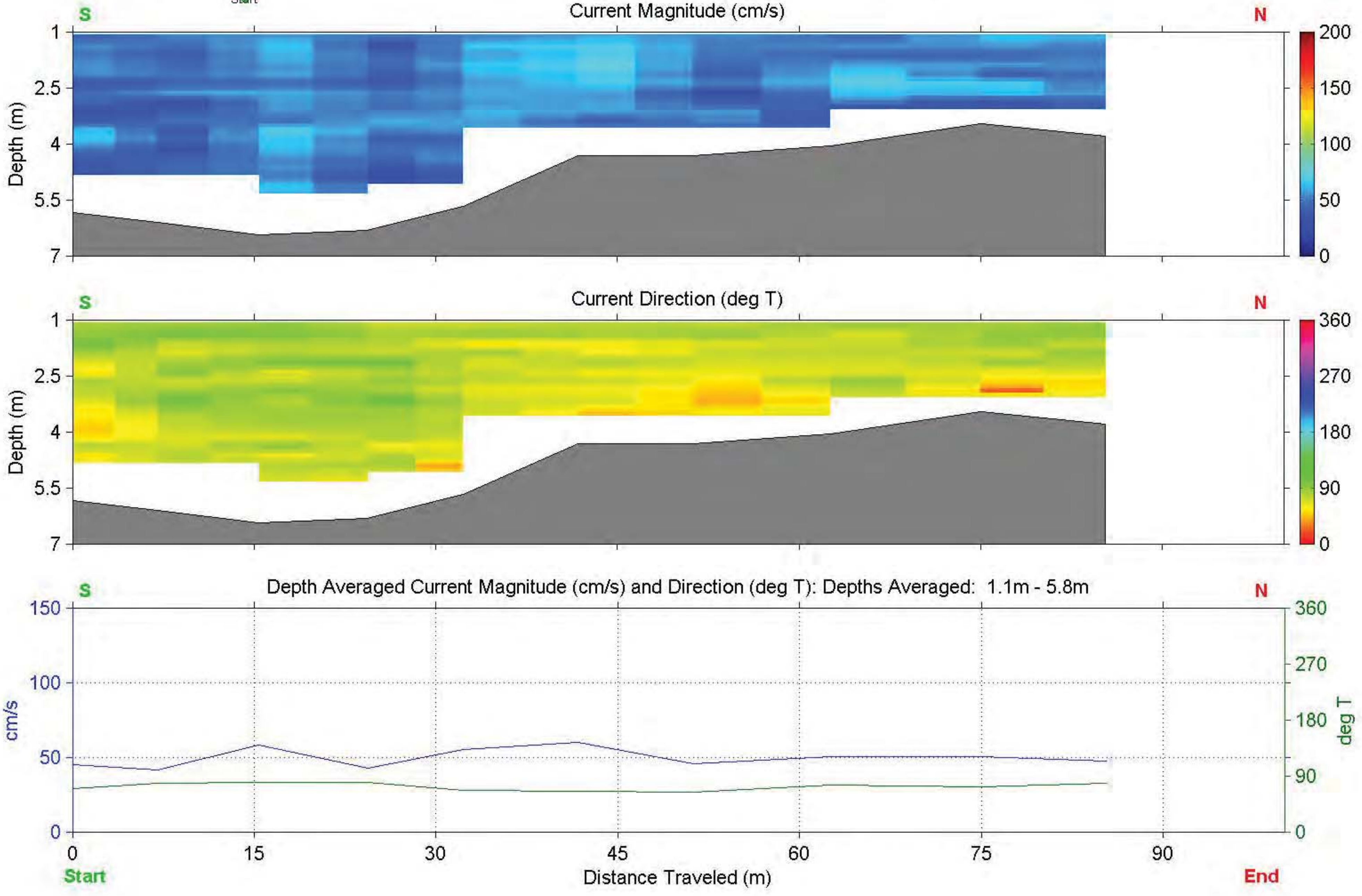

Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 29, 2017

Measurement Time: 16:59 - 17:01 UTC (# Ensembles Averaged: 3)



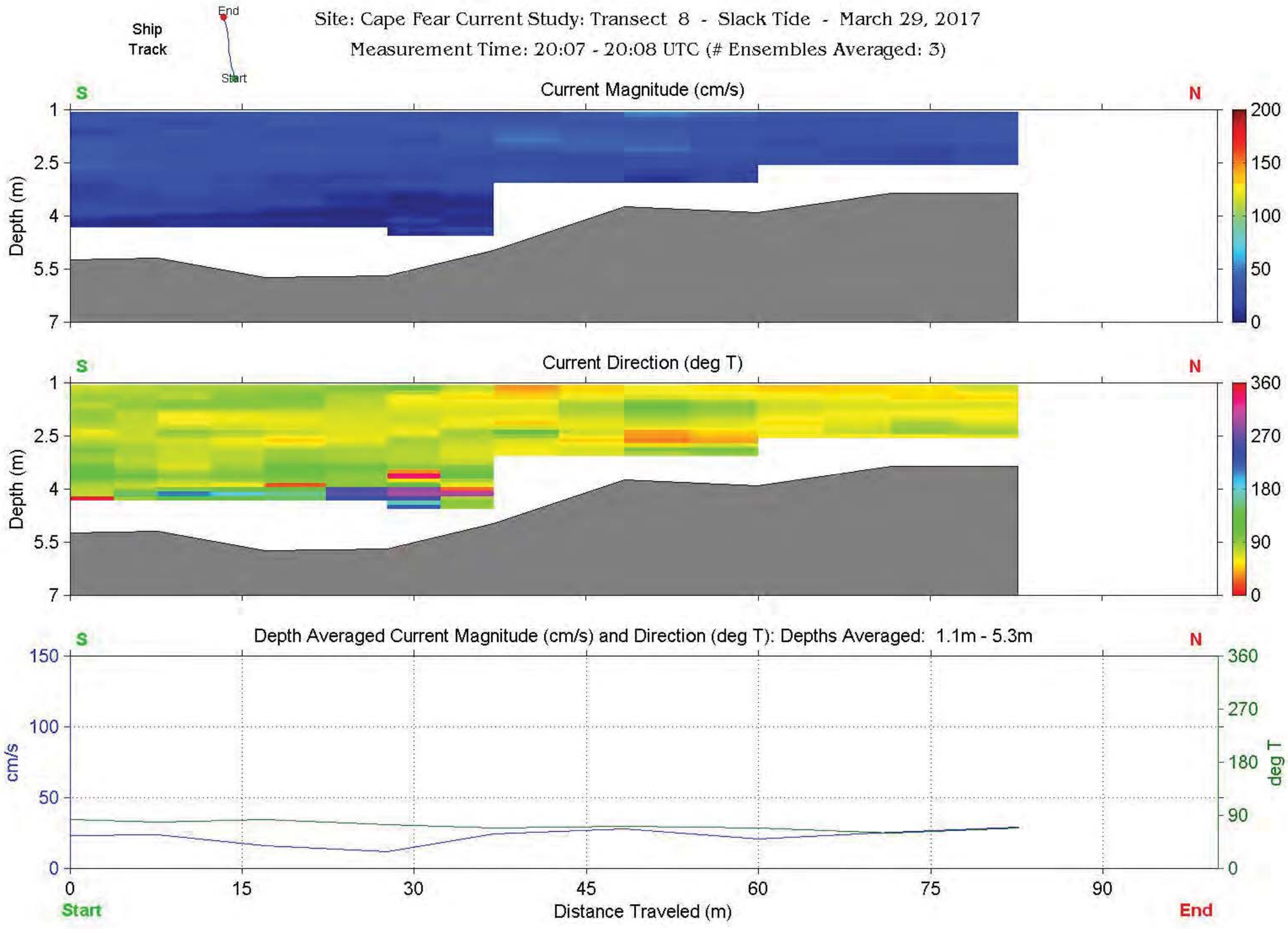
Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 29, 2017

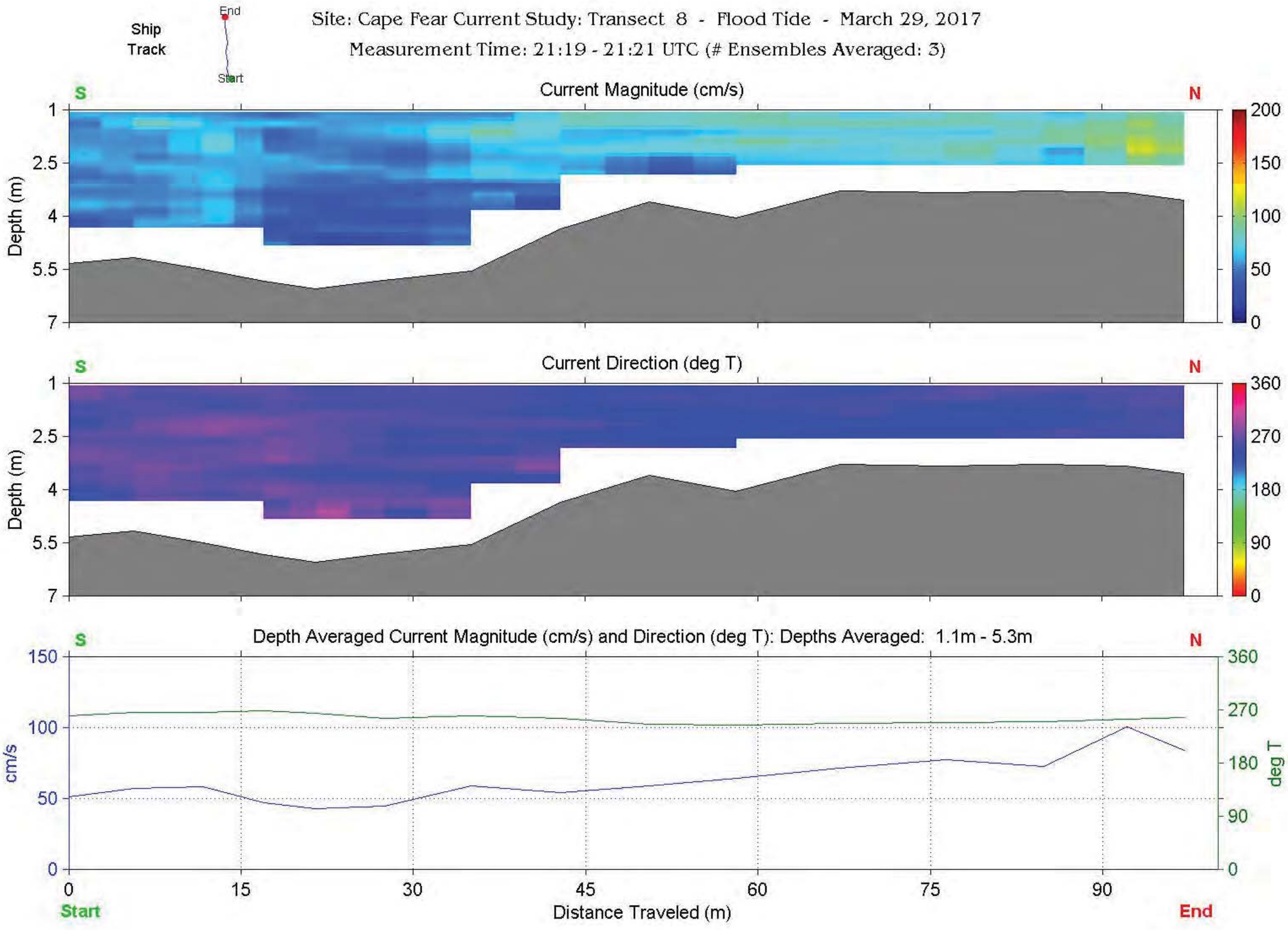
Measurement Time: 17:59 - 18:00 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 8 - Slack Tide - March 29, 2017

Measurement Time: 20:07 - 20:08 UTC (# Ensembles Averaged: 3)



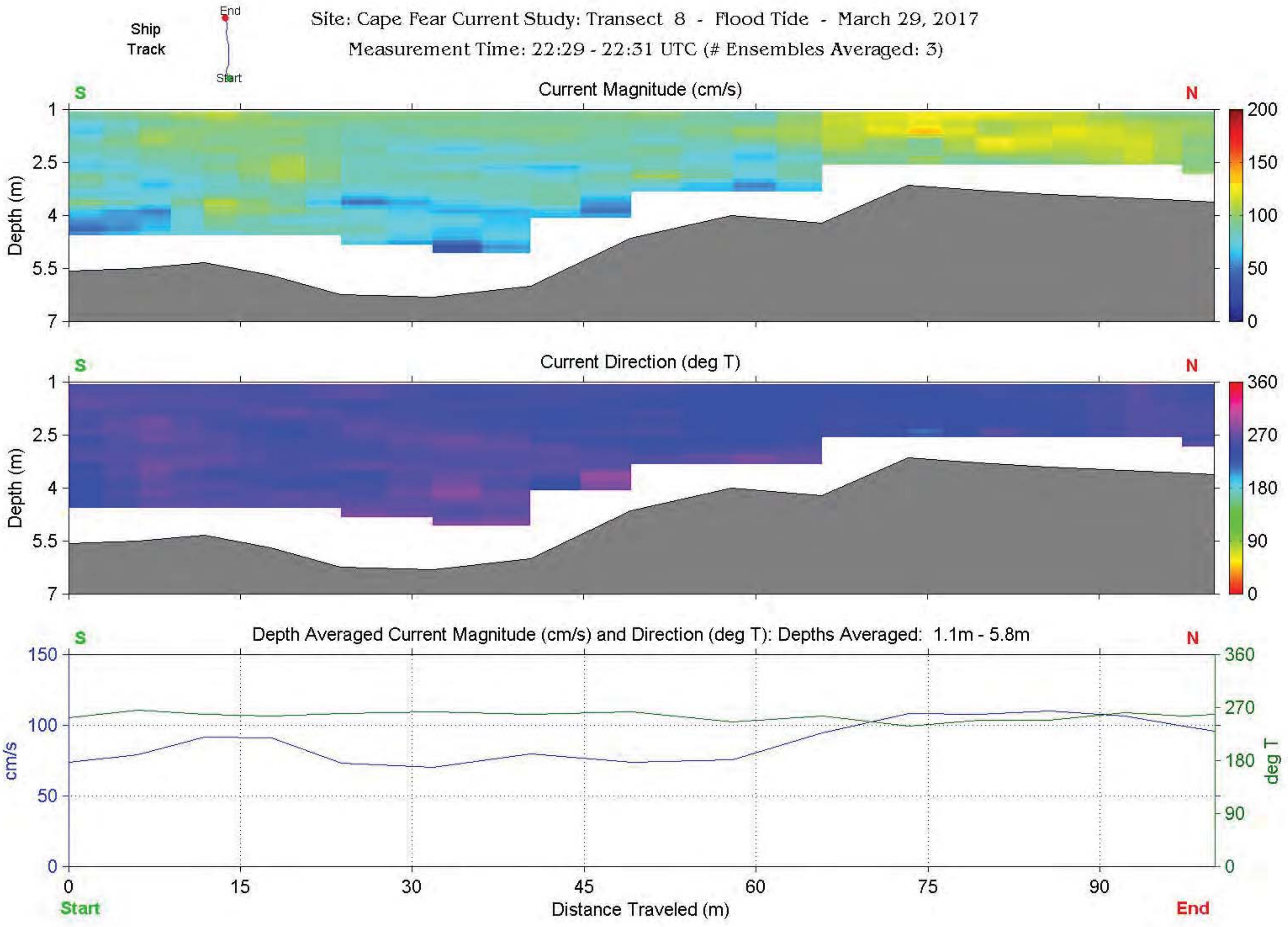


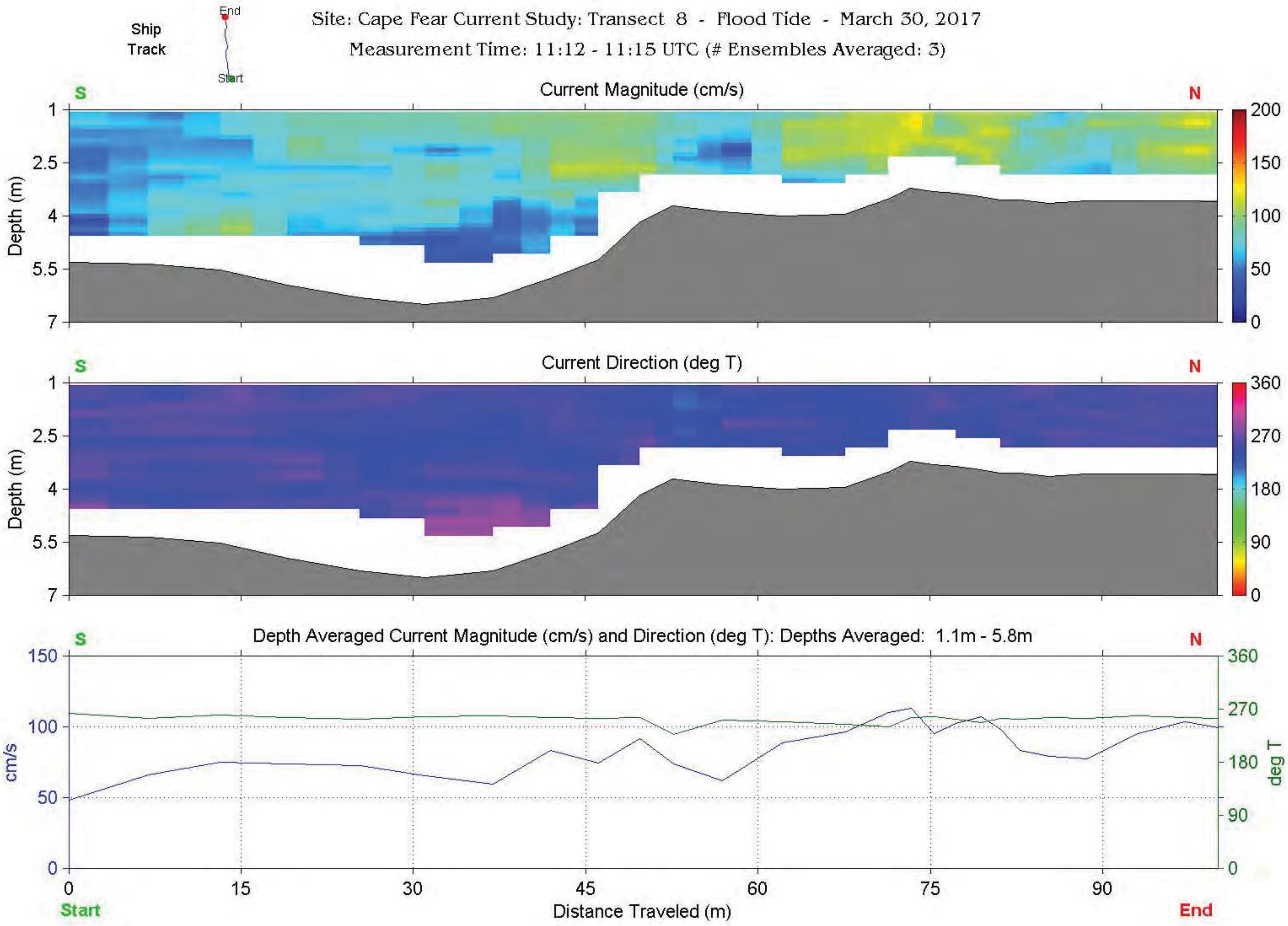
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 29, 2017

Measurement Time: 21:19 - 21:21 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 29, 2017

Measurement Time: 22:29 - 22:31 UTC (# Ensembles Averaged: 3)





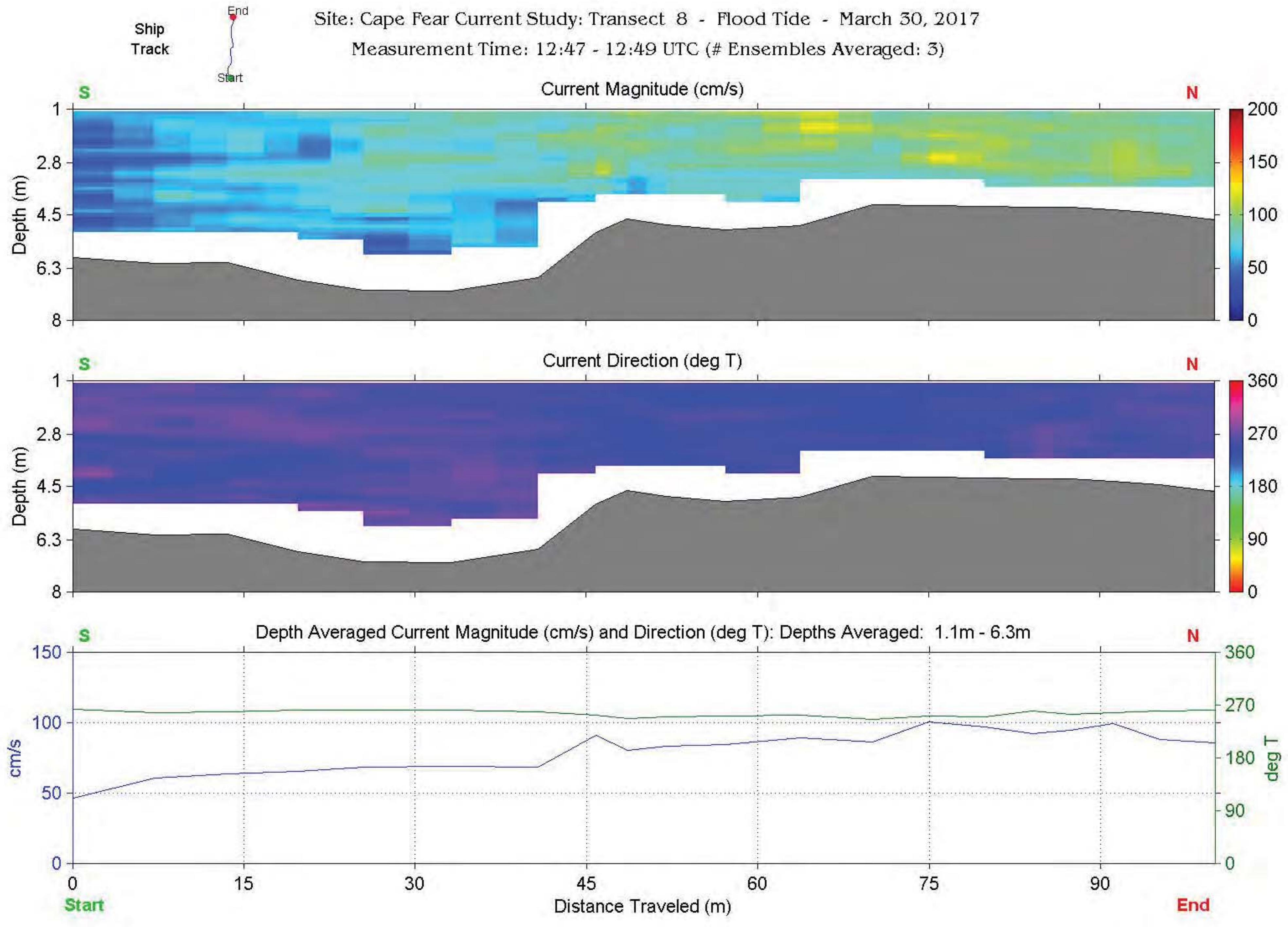
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 30, 2017

Measurement Time: 11:12 - 11:15 UTC (# Ensembles Averaged: 3)

Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.1m - 5.8m

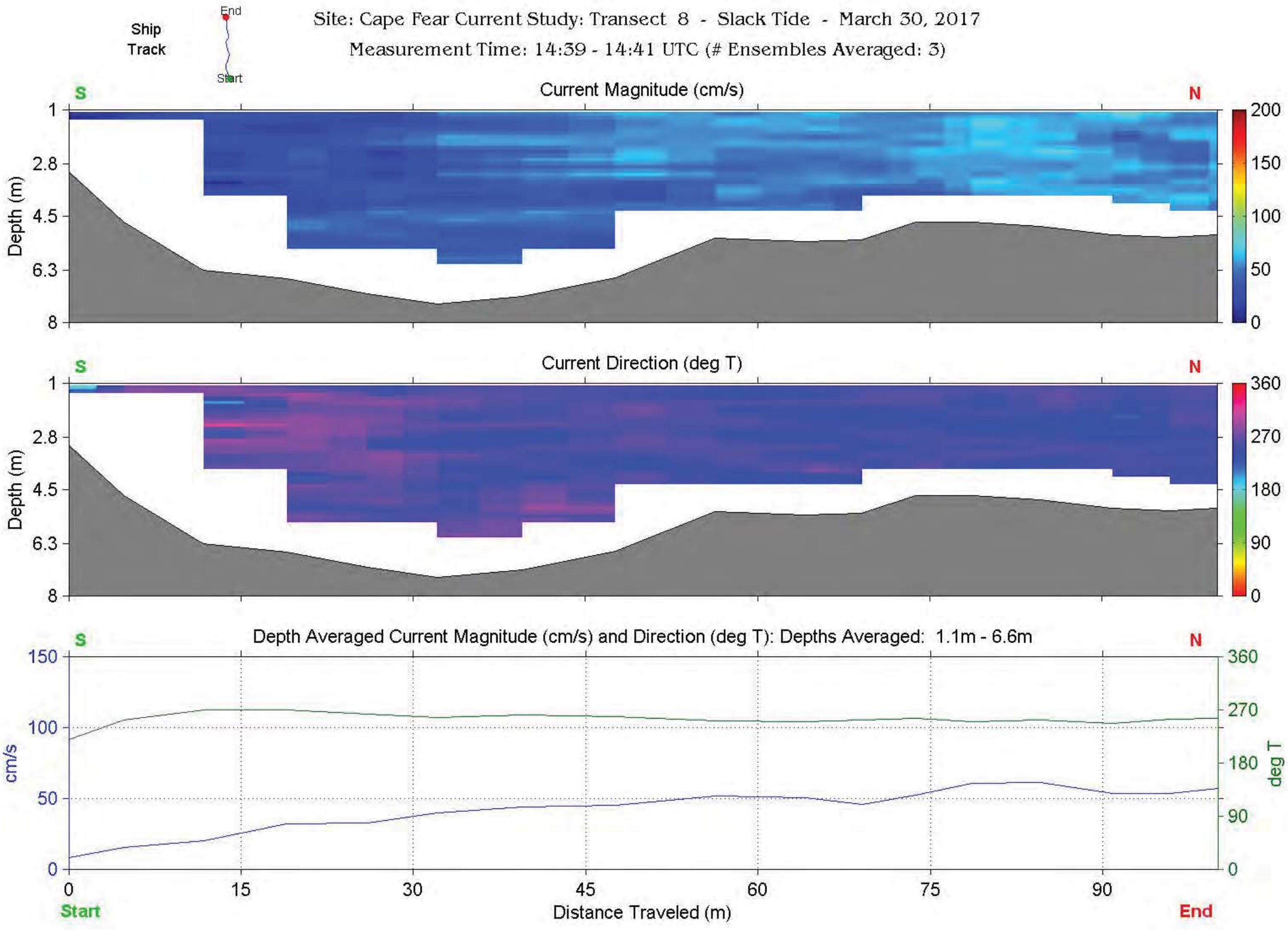


Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 30, 2017

Measurement Time: 12:47 - 12:49 UTC (# Ensembles Averaged: 3)

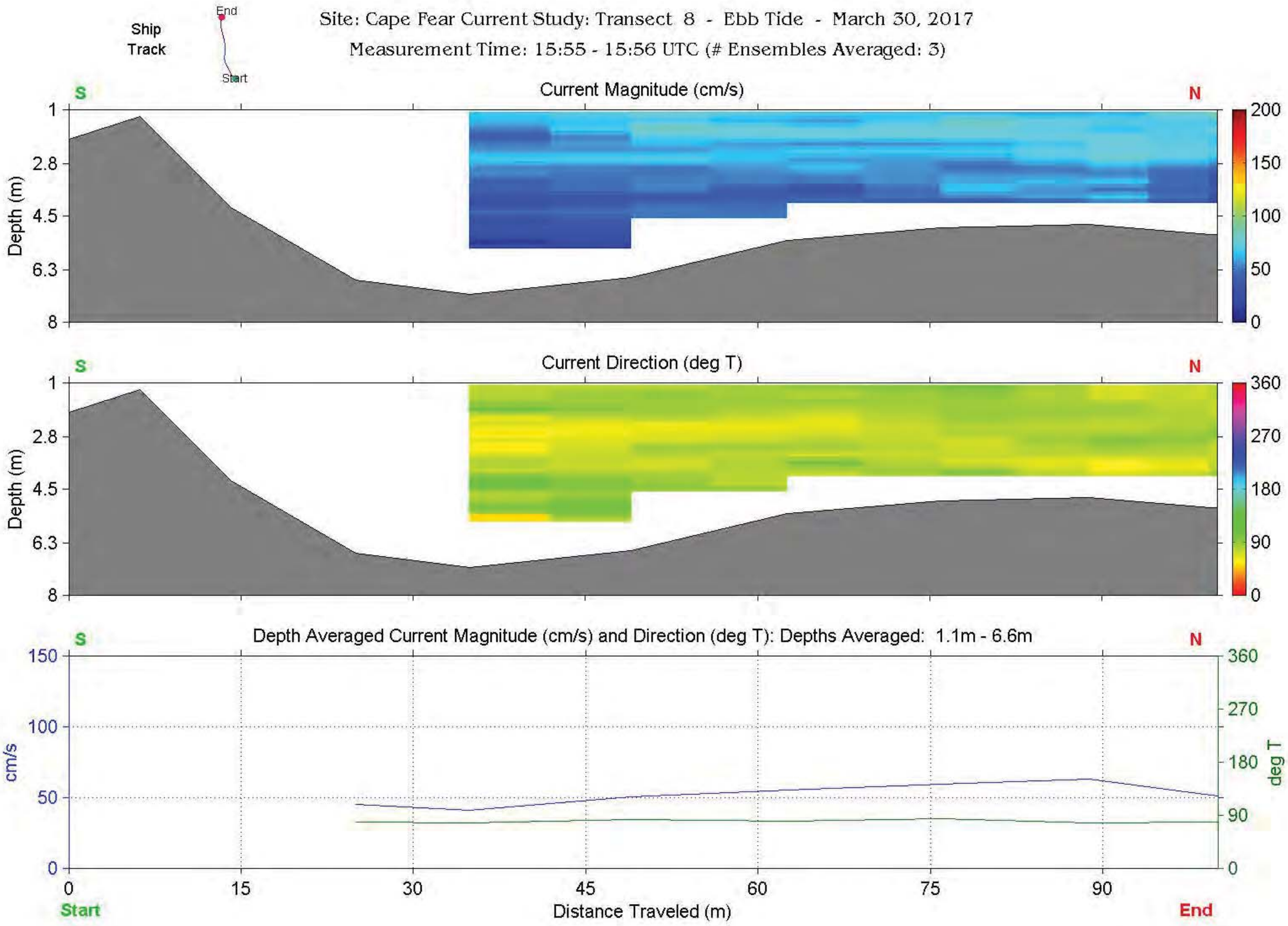
Site: Cape Fear Current Study: Transect 8 - Slack Tide - March 30, 2017

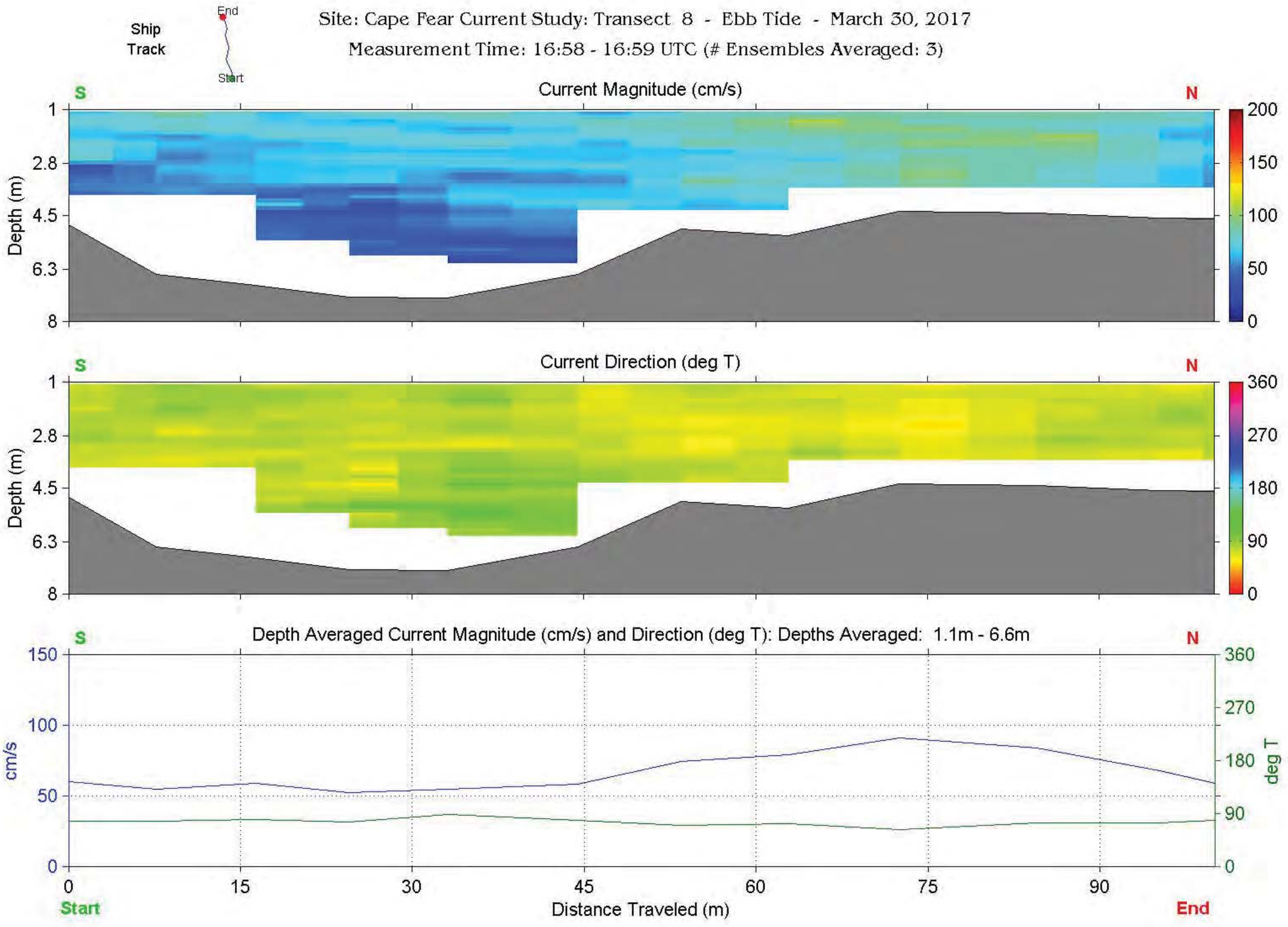
Measurement Time: 14:39 - 14:41 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 30, 2017

Measurement Time: 15:55 - 15:56 UTC (# Ensembles Averaged: 3)



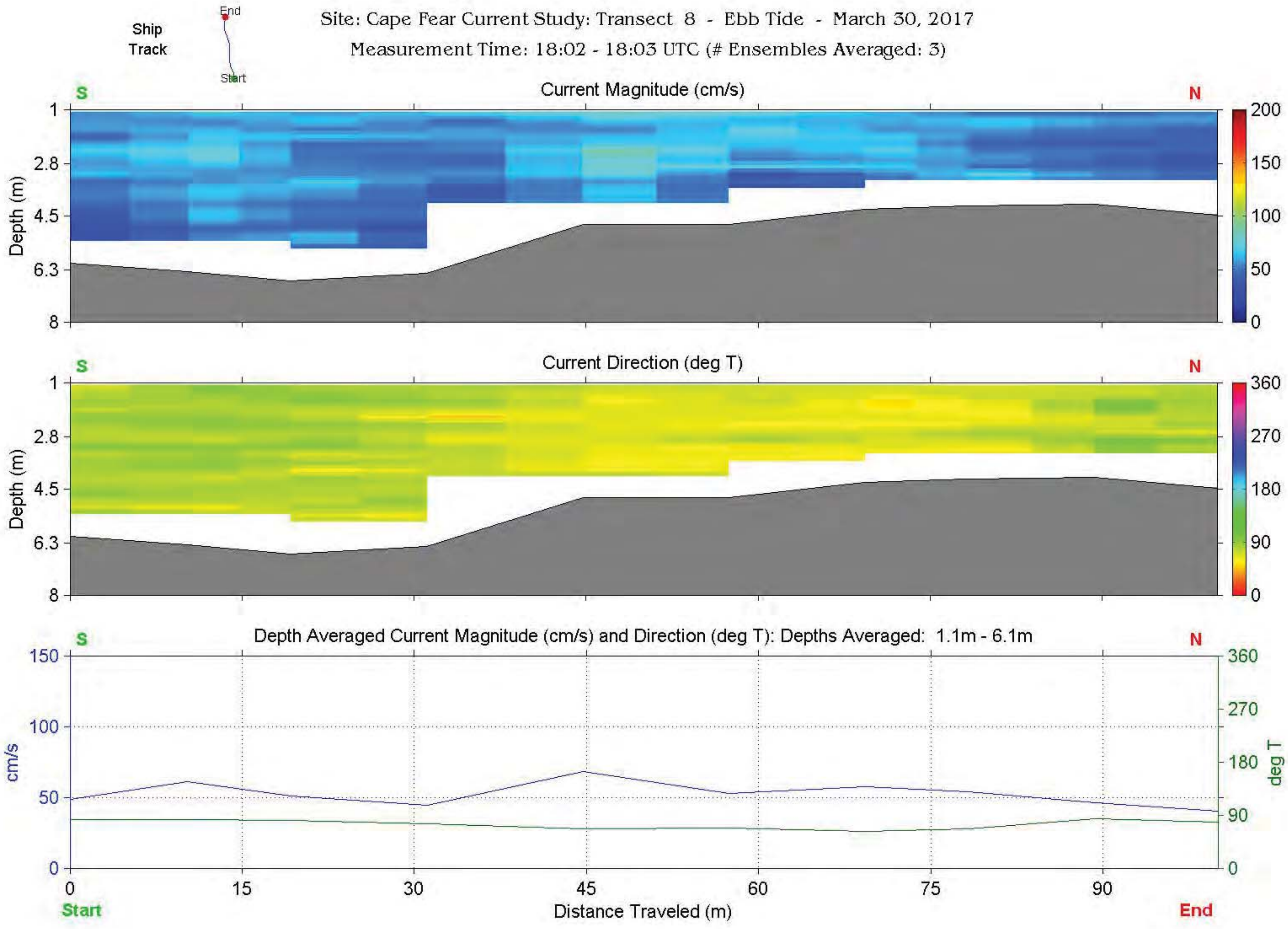


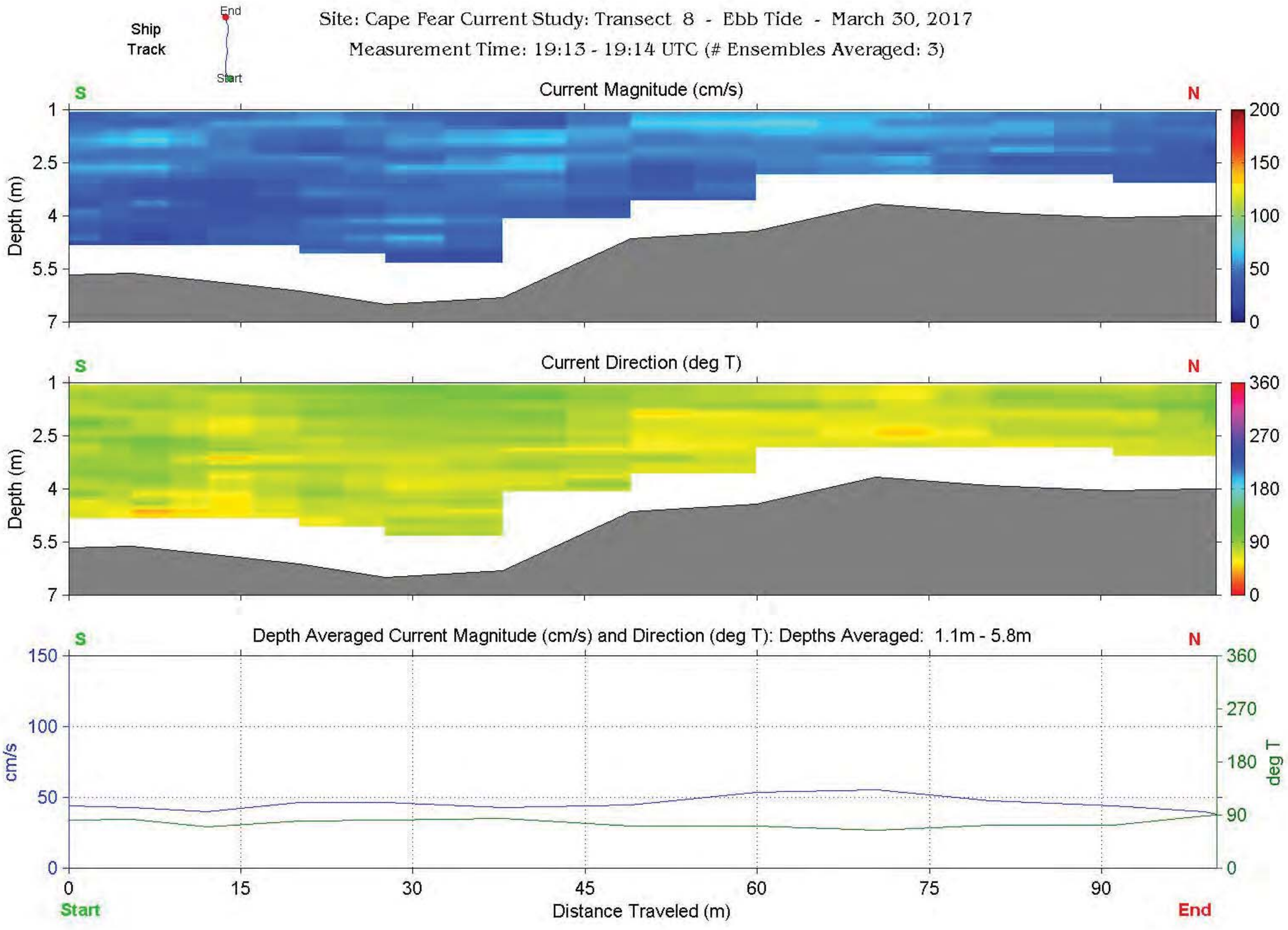
Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 30, 2017

Measurement Time: 16:58 - 16:59 UTC (# Ensembles Averaged: 3)

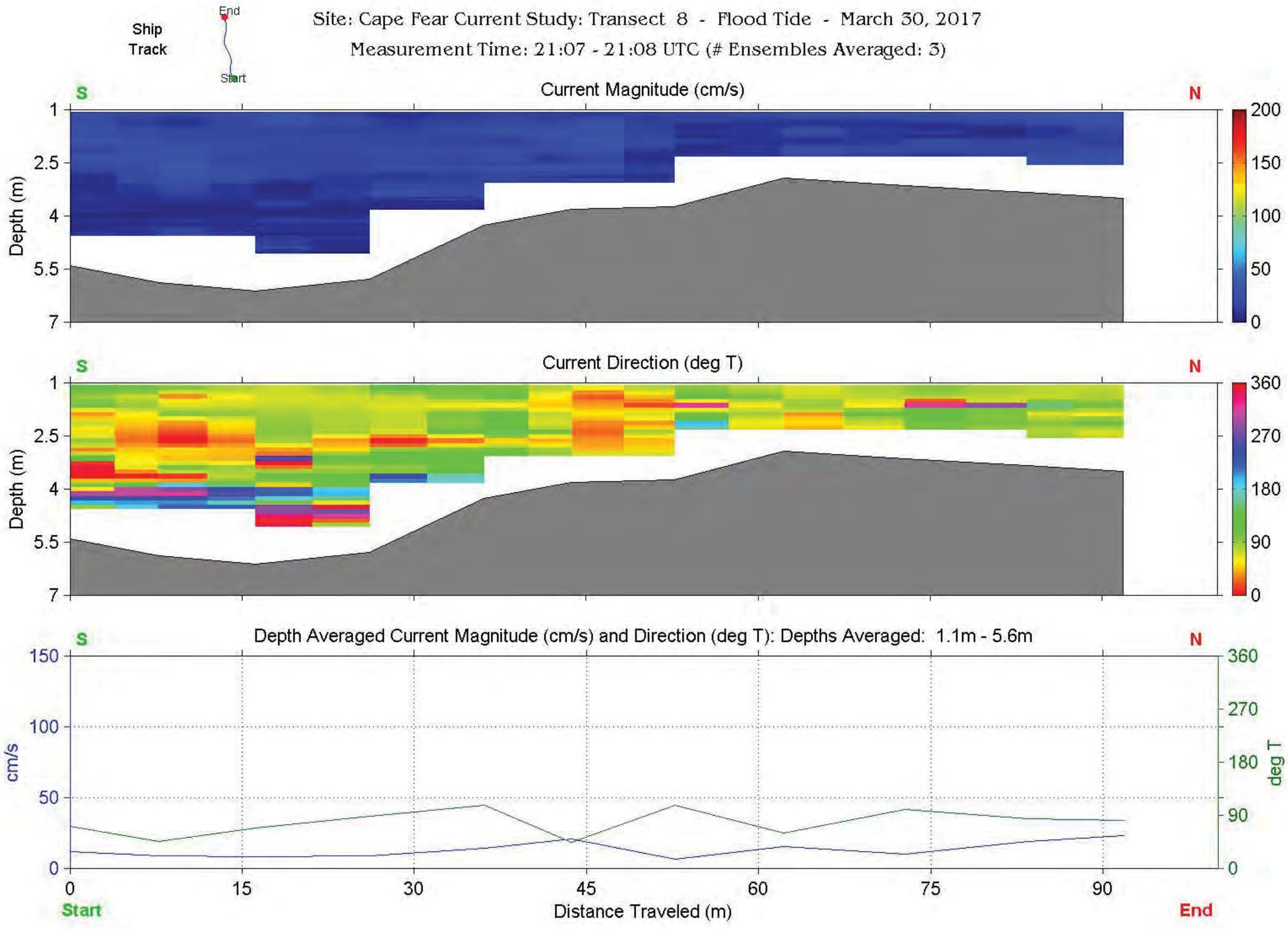
Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 30, 2017

Measurement Time: 18:02 - 18:03 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 30, 2017

Measurement Time: 19:13 - 19:14 UTC (# Ensembles Averaged: 3)

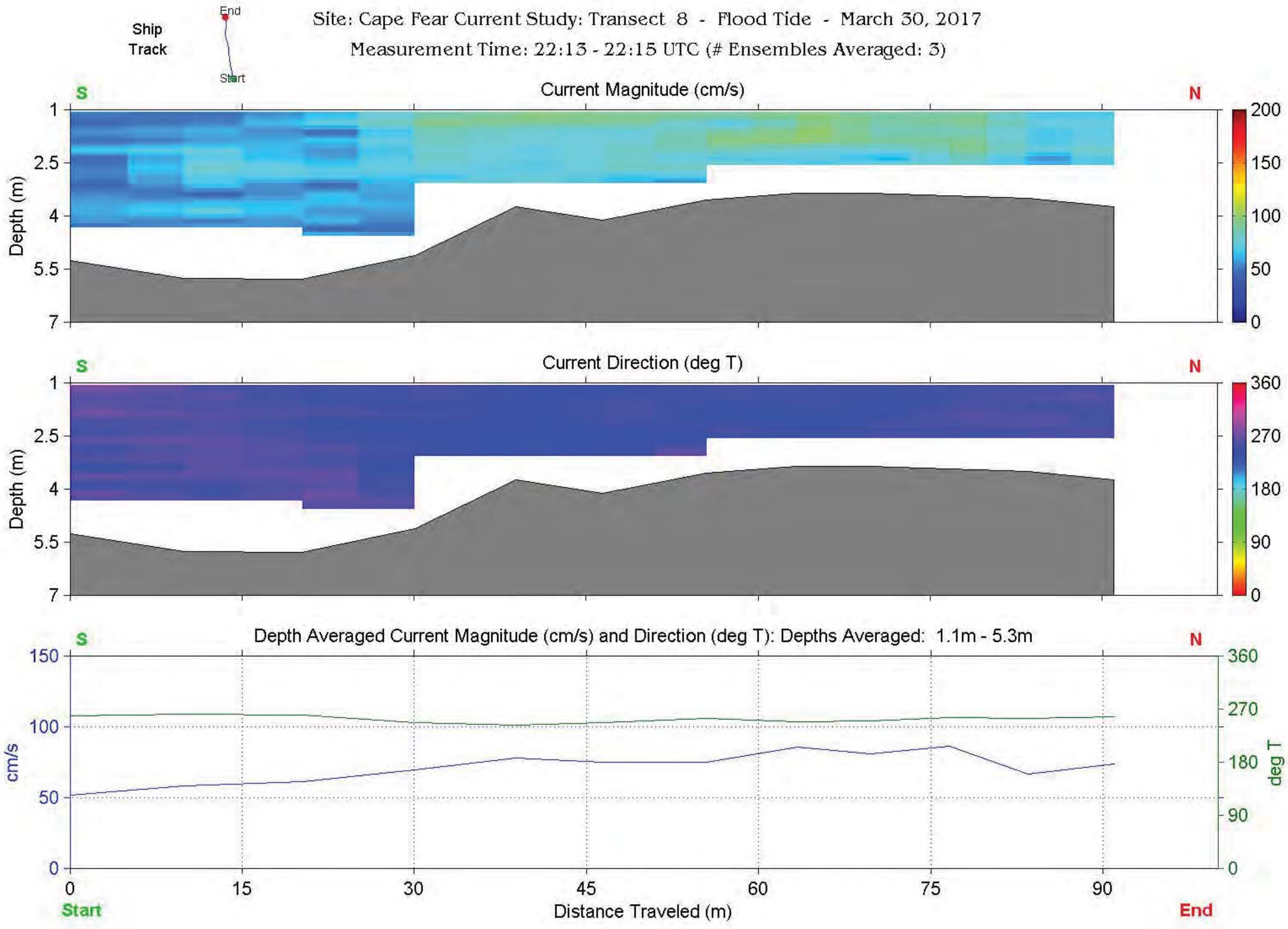


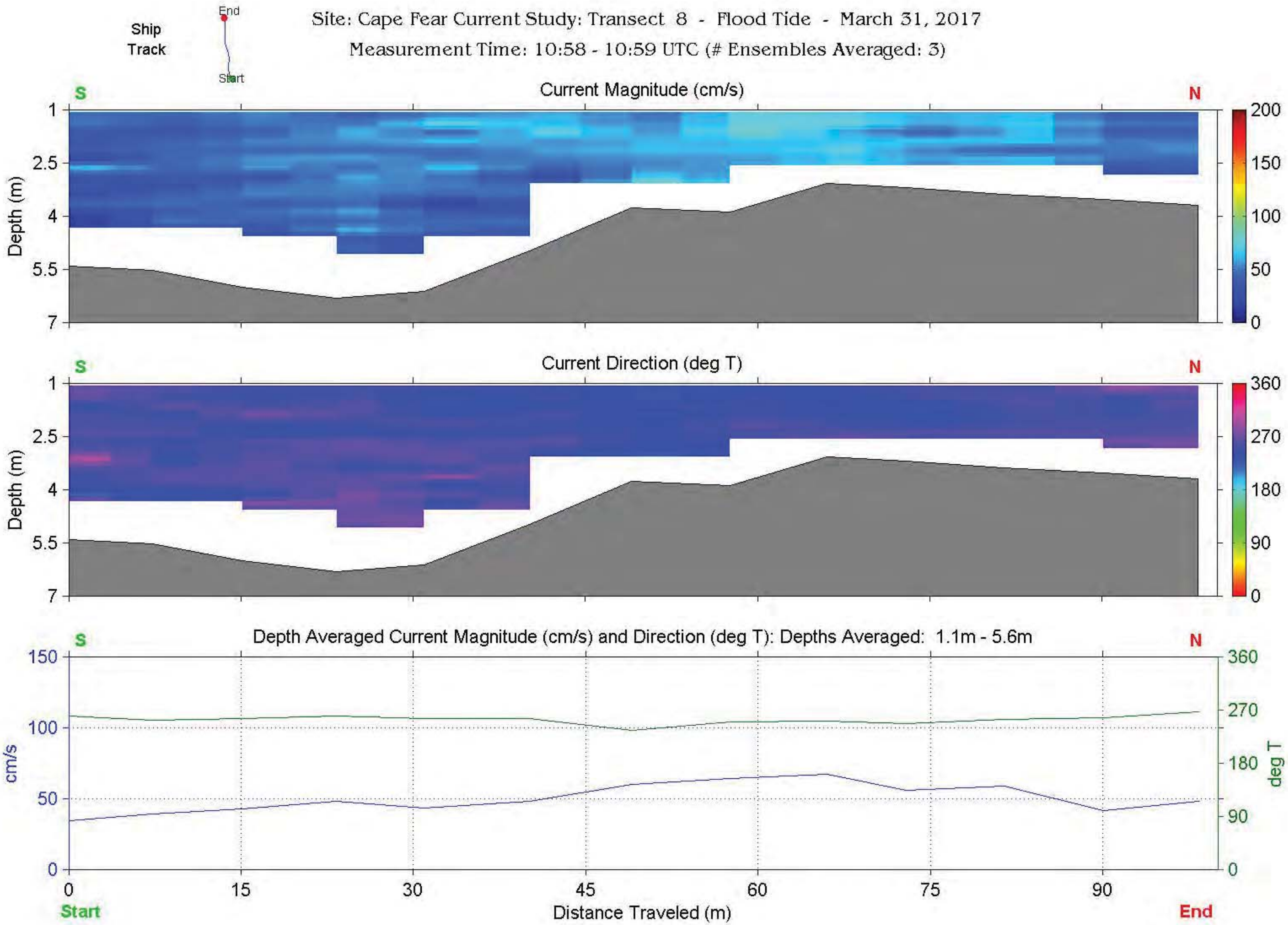
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 30, 2017

Measurement Time: 21:07 - 21:08 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 30, 2017

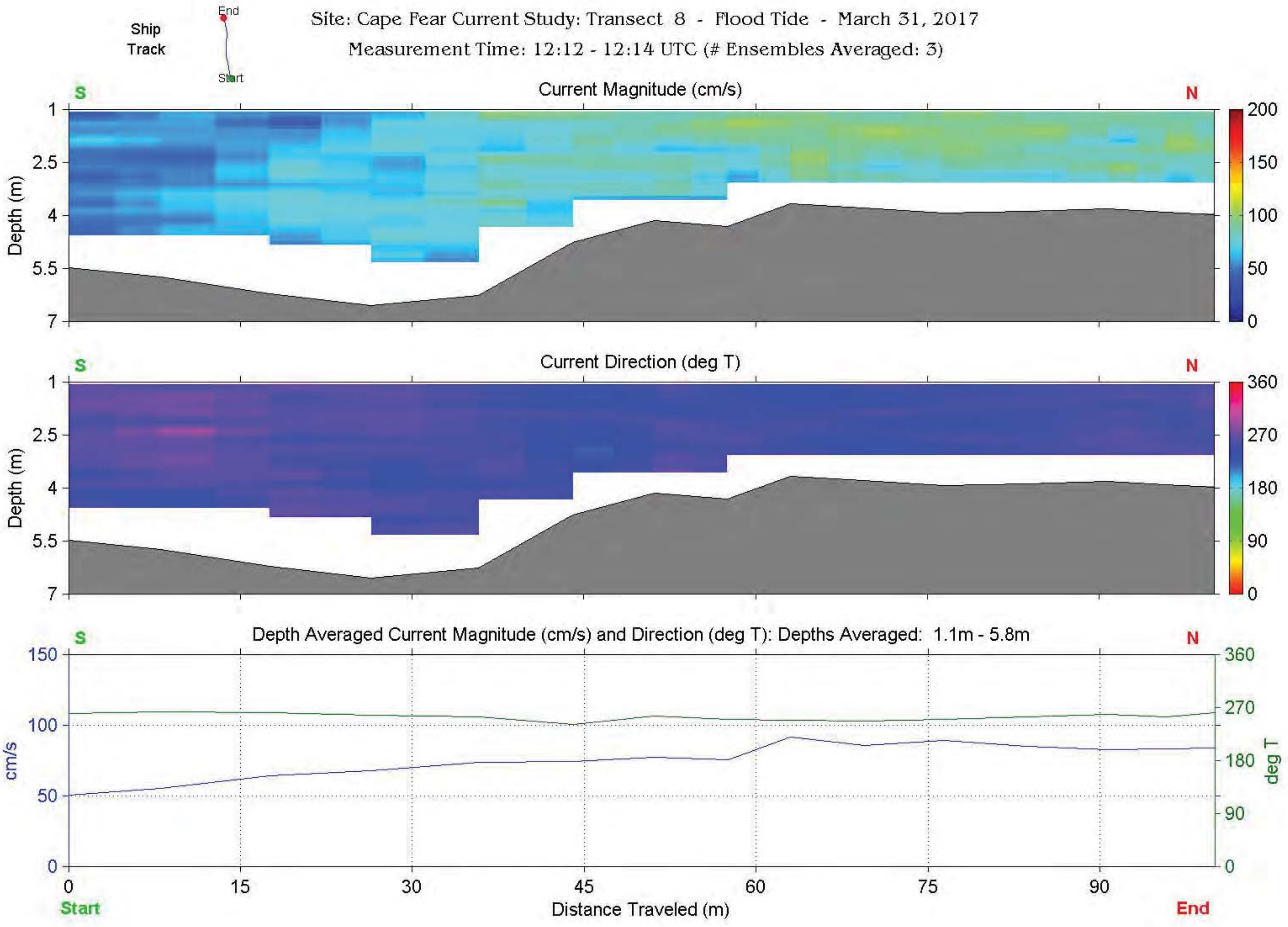
Measurement Time: 22:13 - 22:15 UTC (# Ensembles Averaged: 3)





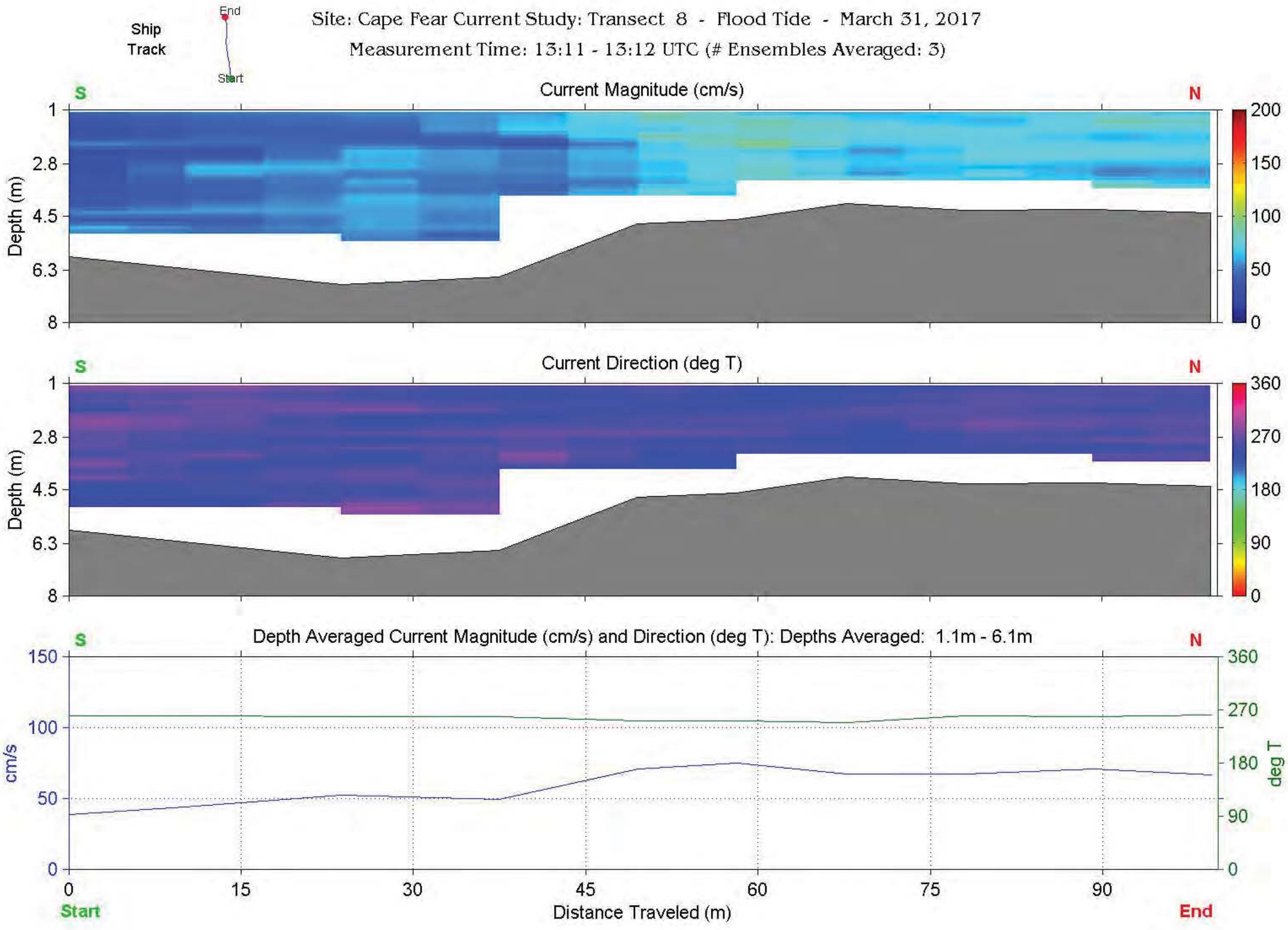
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 31, 2017

Measurement Time: 10:58 - 10:59 UTC (# Ensembles Averaged: 3)


Ship Track
End
Start
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 31, 2017
Measurement Time: 12:12 - 12:14 UTC (# Ensembles Averaged: 3)
S
Current Magnitude (cm/s)
N
Depth (m)
1
2.5
4
5.5
7
200
150
100
50
0
S
Current Direction (deg T)
N
Depth (m)
1
2.5
4
5.5
7
360
270
180
90
0
S
Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.1m - 5.8m
N
cm/s
150
100
50
0
deg T
360
270
180
90
0
0
15
30
45
60
75
90
Start
Distance Traveled (m)
End

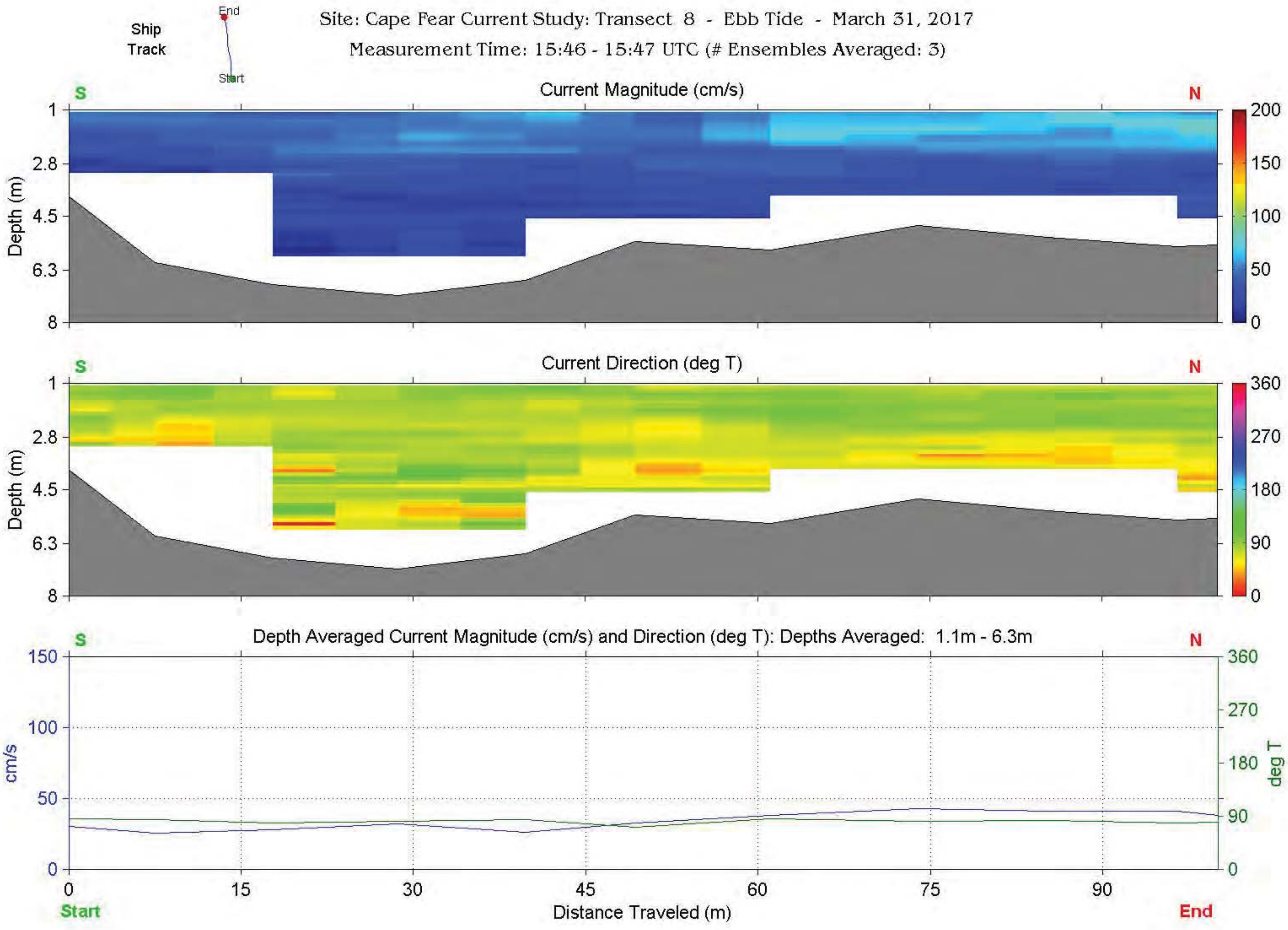
Site: Cape Fear Current Study: Transect 8 - Flood Tide - March 31, 2017

Measurement Time: 13:11 - 13:12 UTC (# Ensembles Averaged: 3)



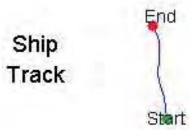
Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 31, 2017

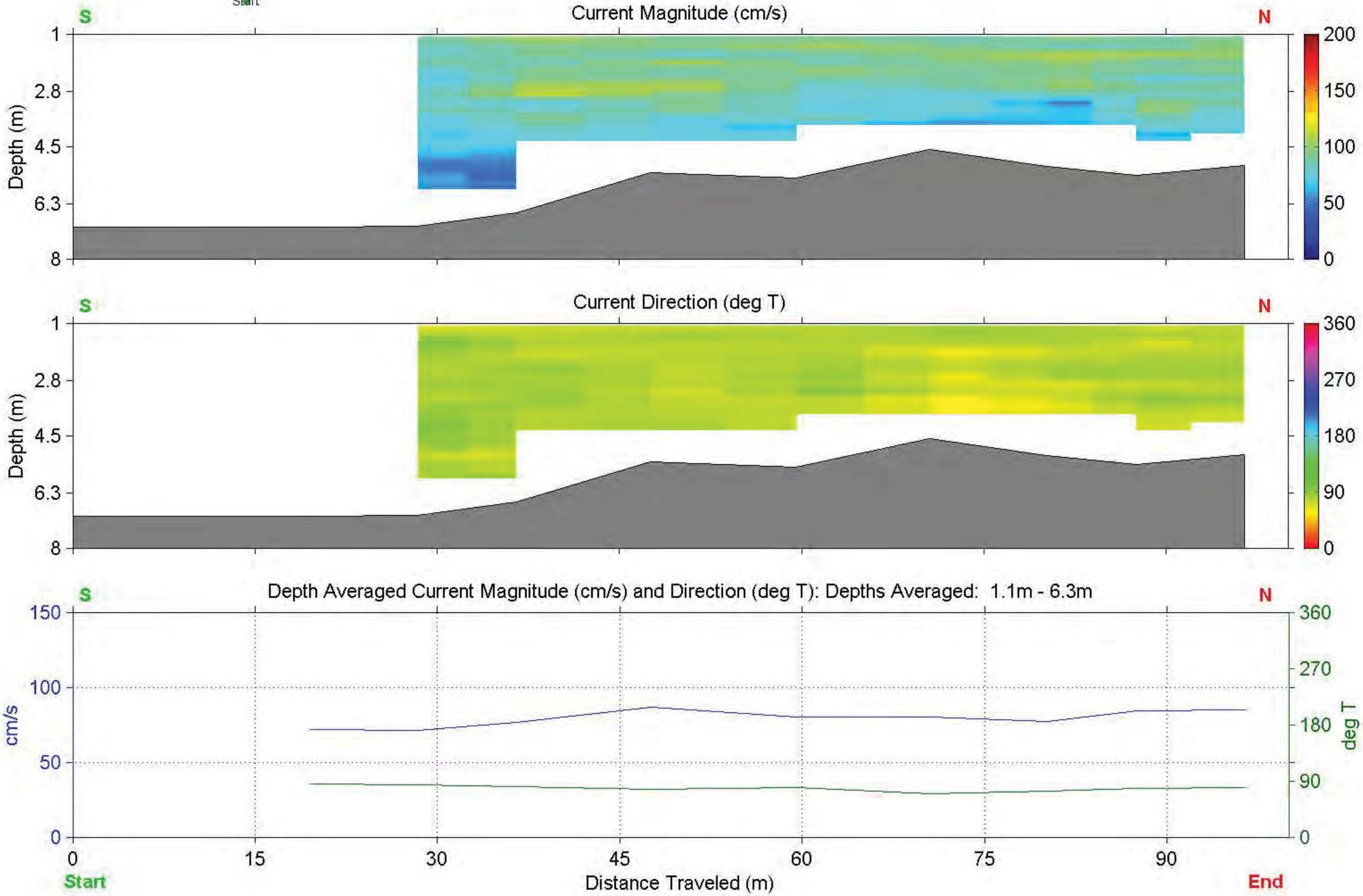
Measurement Time: 15:46 - 15:47 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 8 - Ebb Tide - March 31, 2017

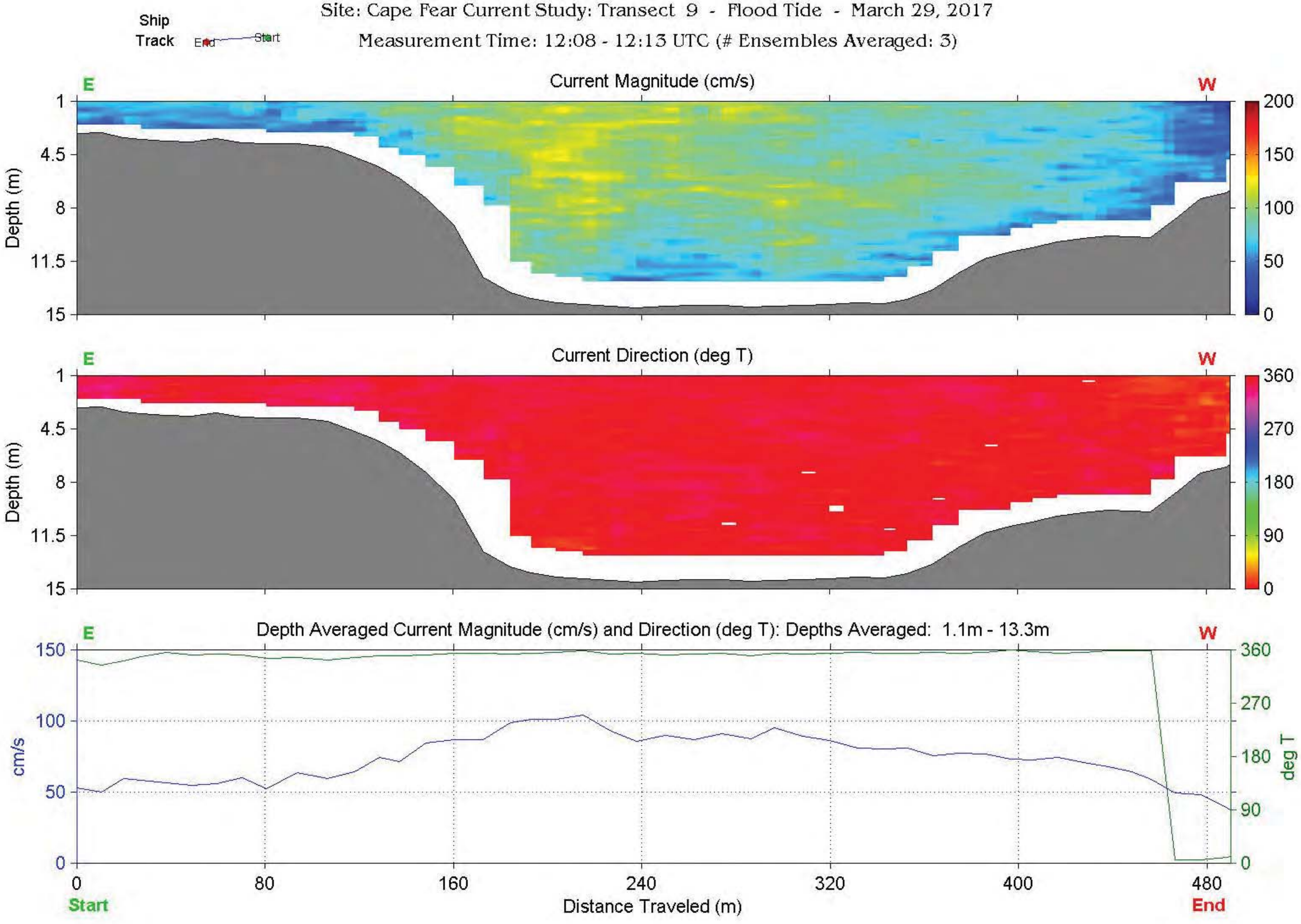
Measurement Time: 16:55 - 16:57 UTC (# Ensembles Averaged: 3)





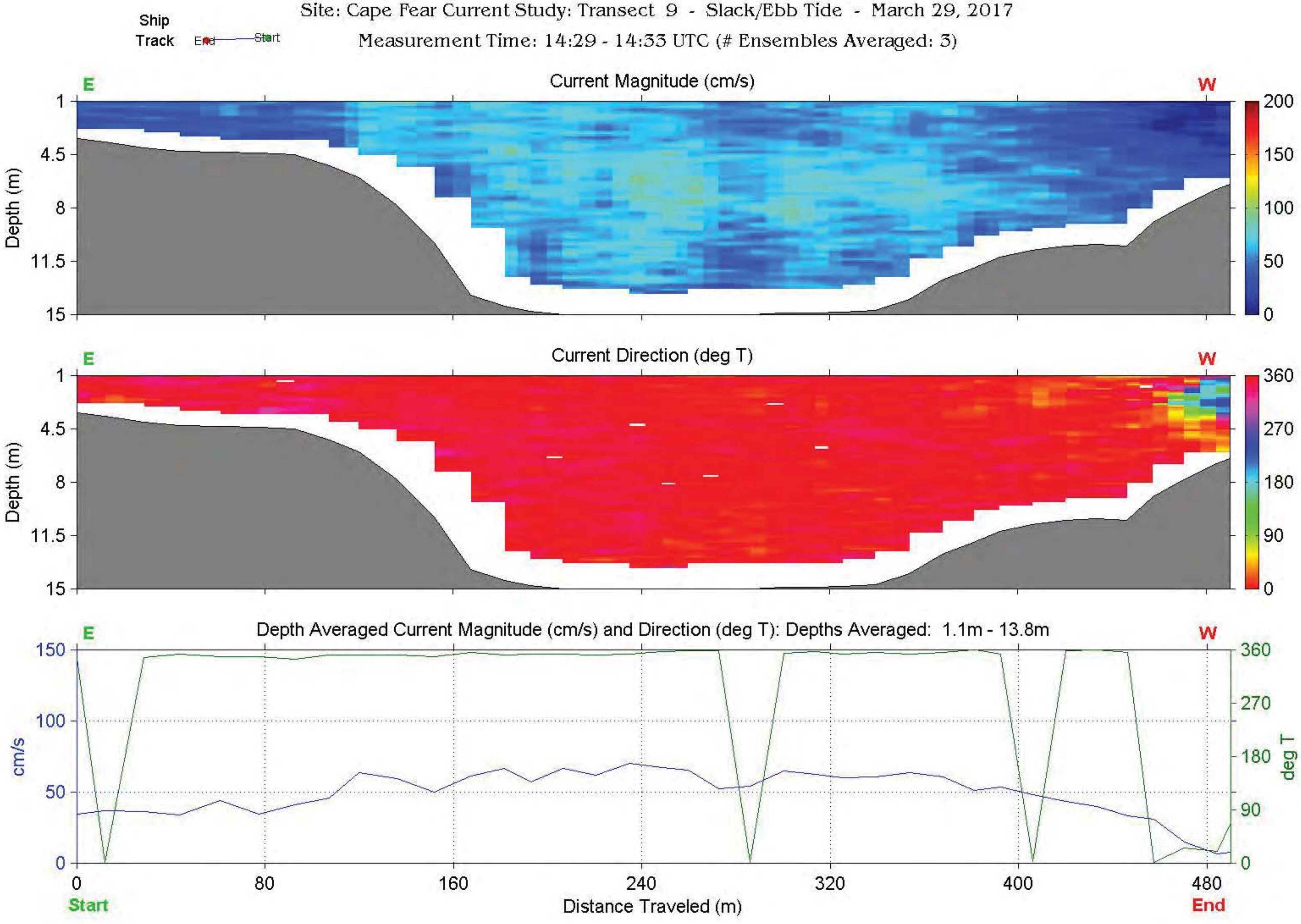
Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 29, 2017

Measurement Time: 12:08 - 12:13 UTC (# Ensembles Averaged: 3)



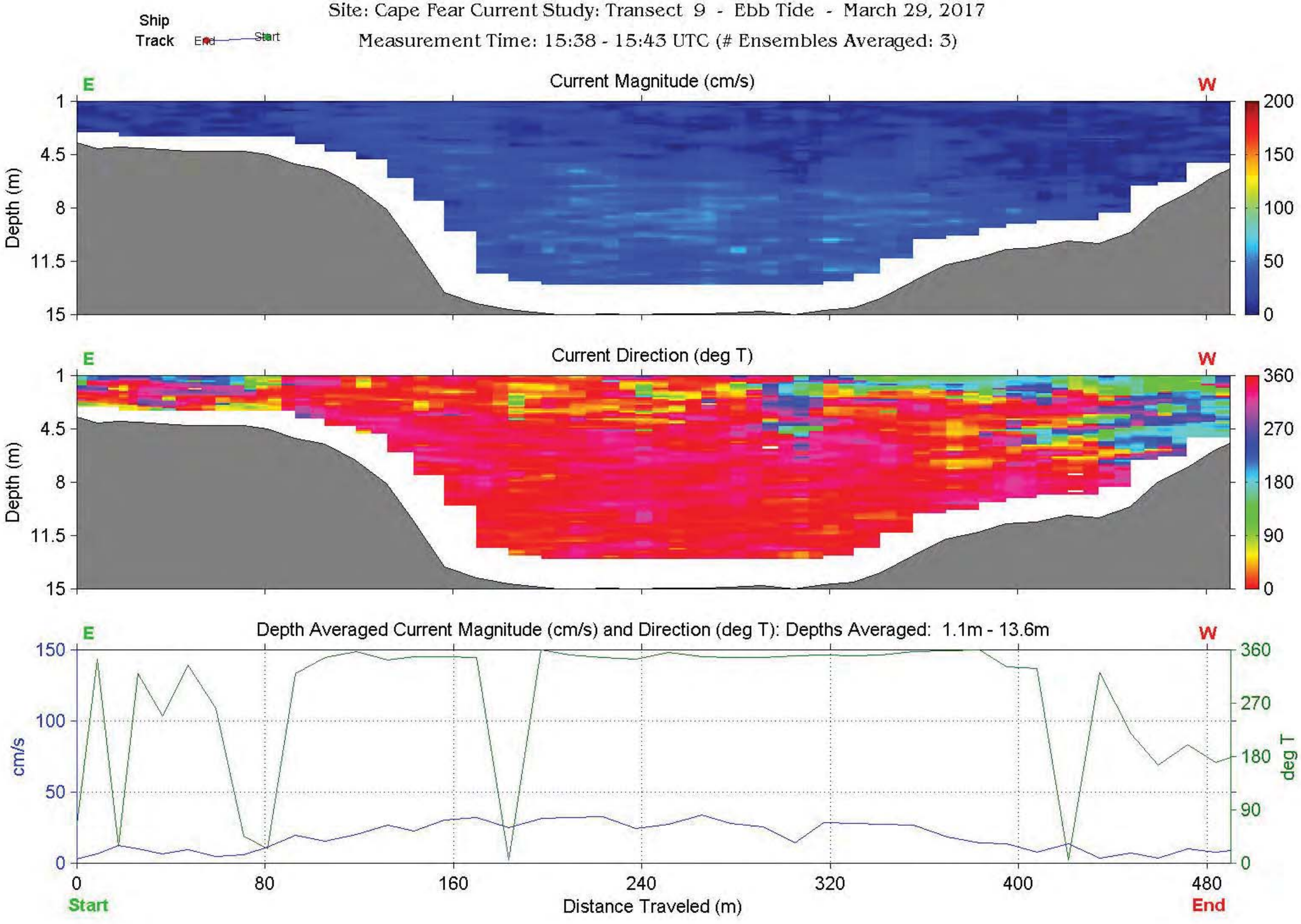
Site: Cape Fear Current Study: Transect 9 - Slack/Ebb Tide - March 29, 2017

Measurement Time: 14:29 - 14:33 UTC (# Ensembles Averaged: 3)



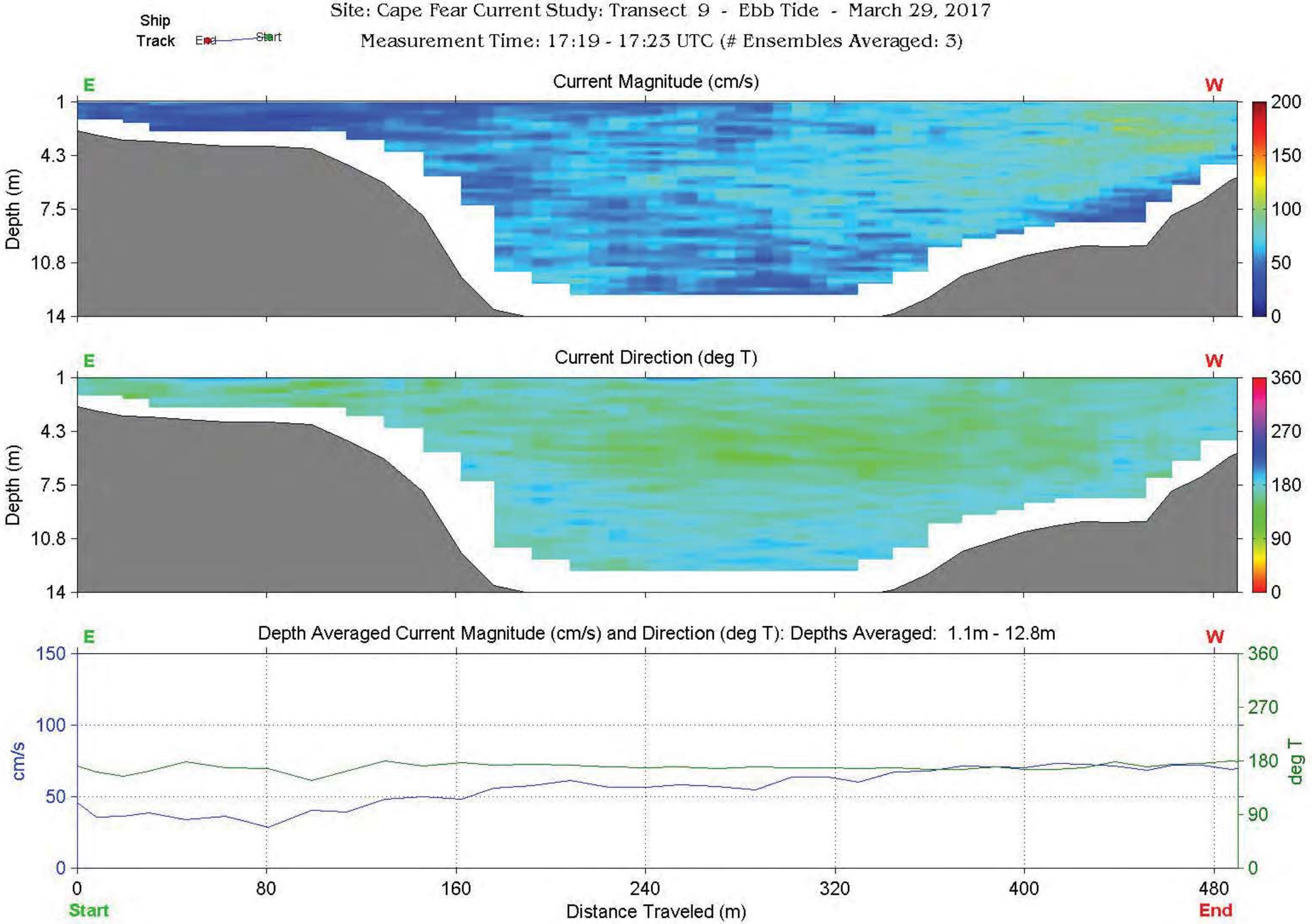
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 29, 2017

Measurement Time: 15:38 - 15:43 UTC (# Ensembles Averaged: 3)



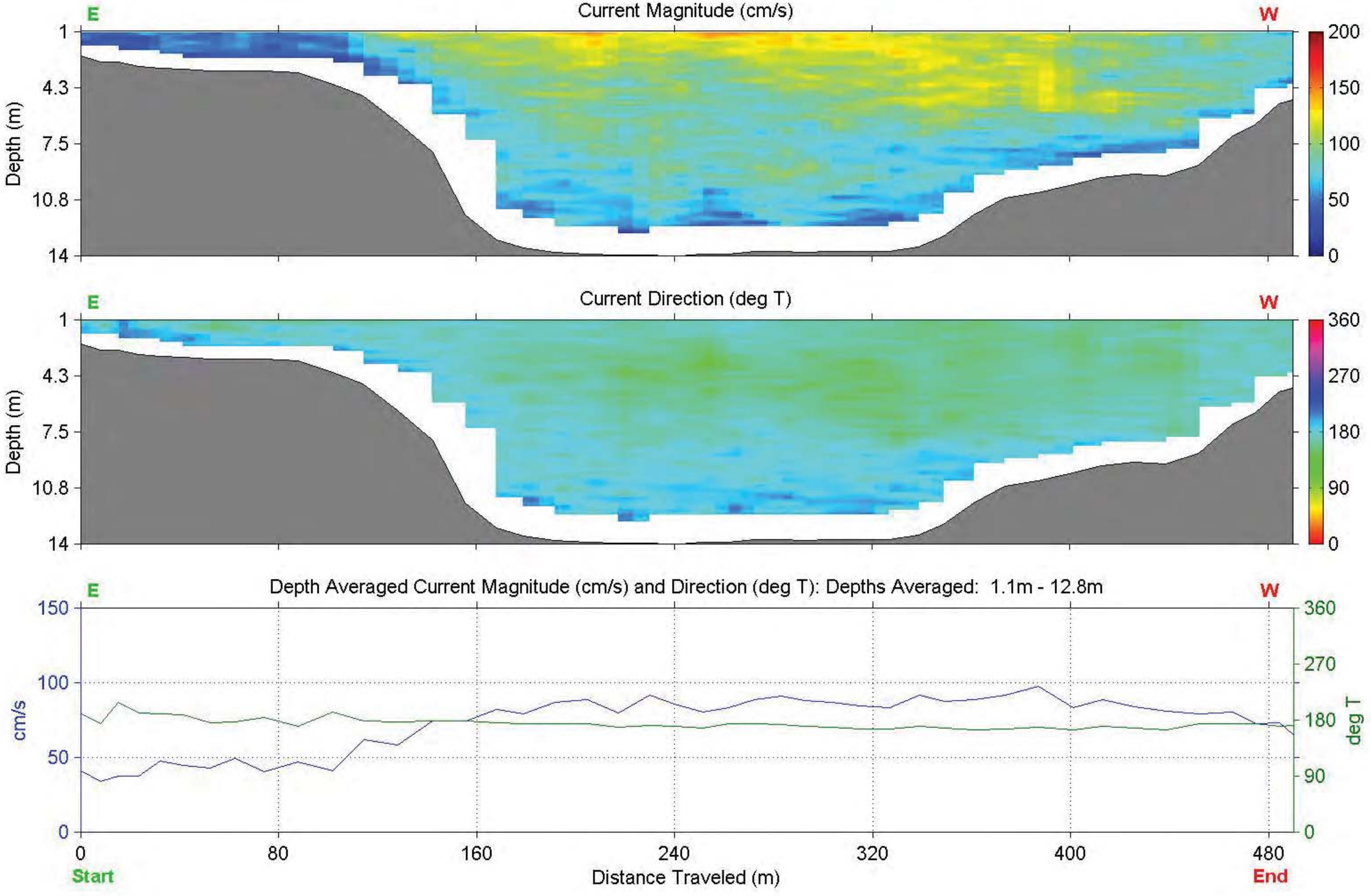
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 29, 2017

Measurement Time: 17:19 - 17:23 UTC (# Ensembles Averaged: 3)



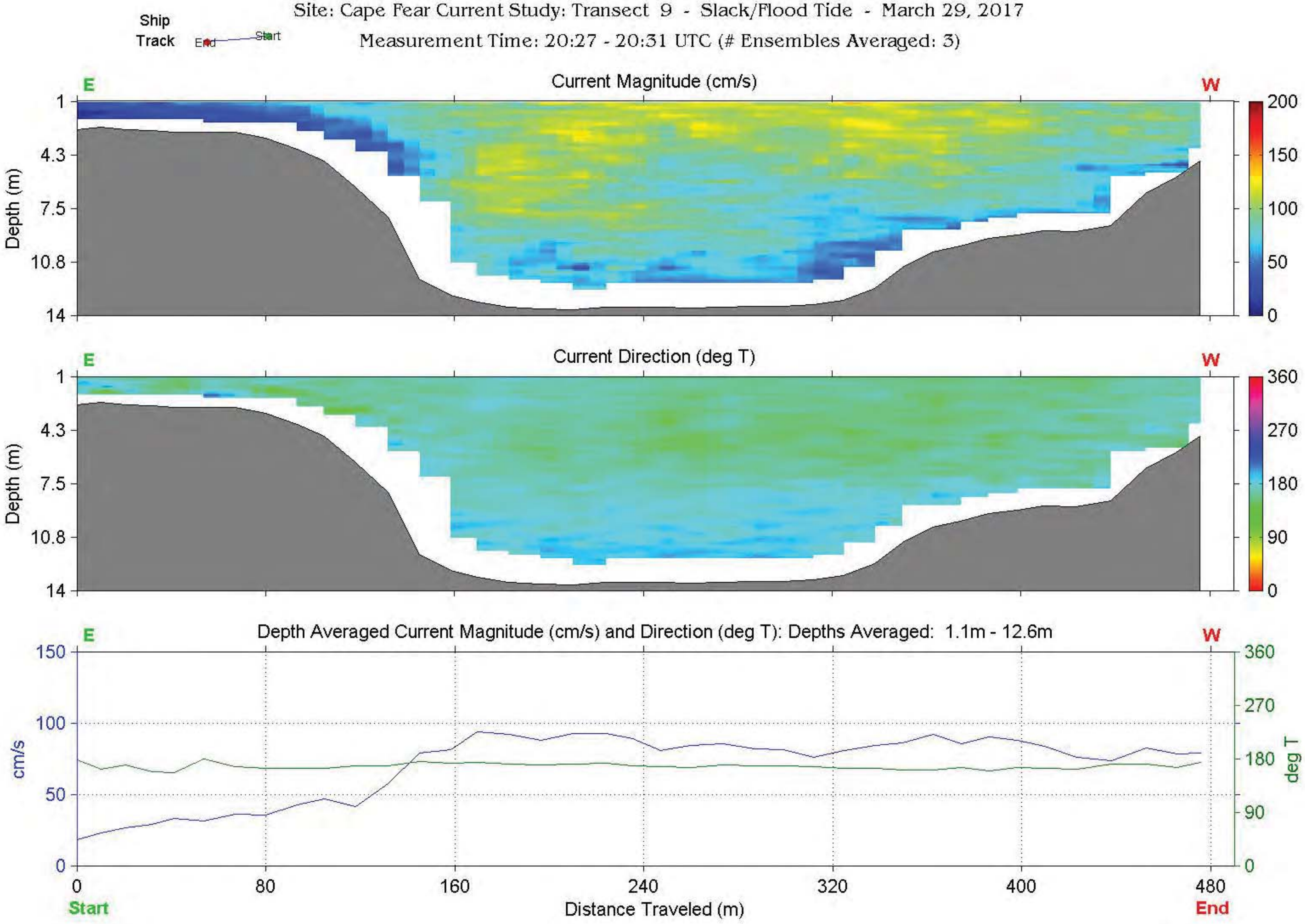
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 29, 2017

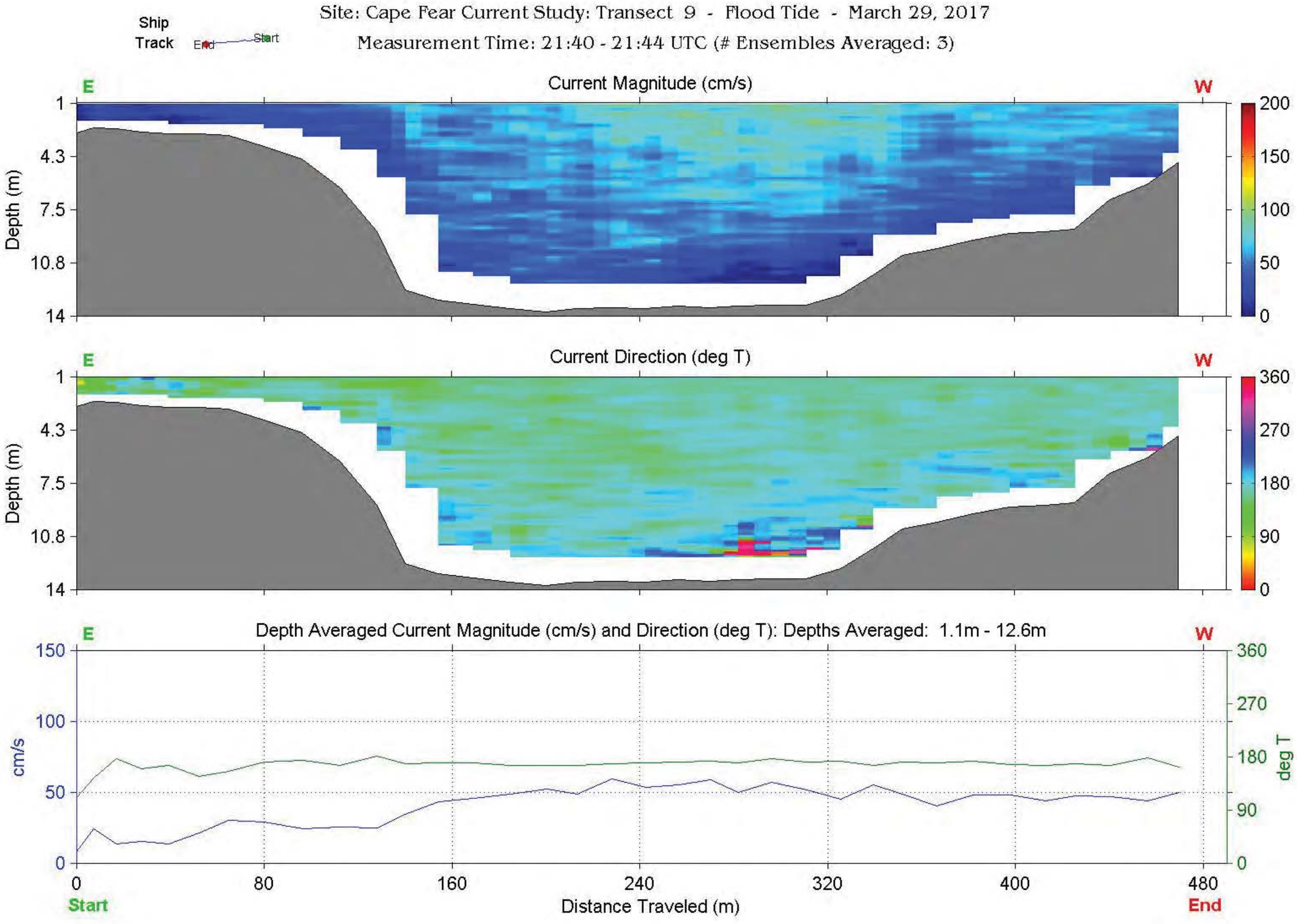
Measurement Time: 18:40 - 18:45 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 9 - Slack/Flood Tide - March 29, 2017

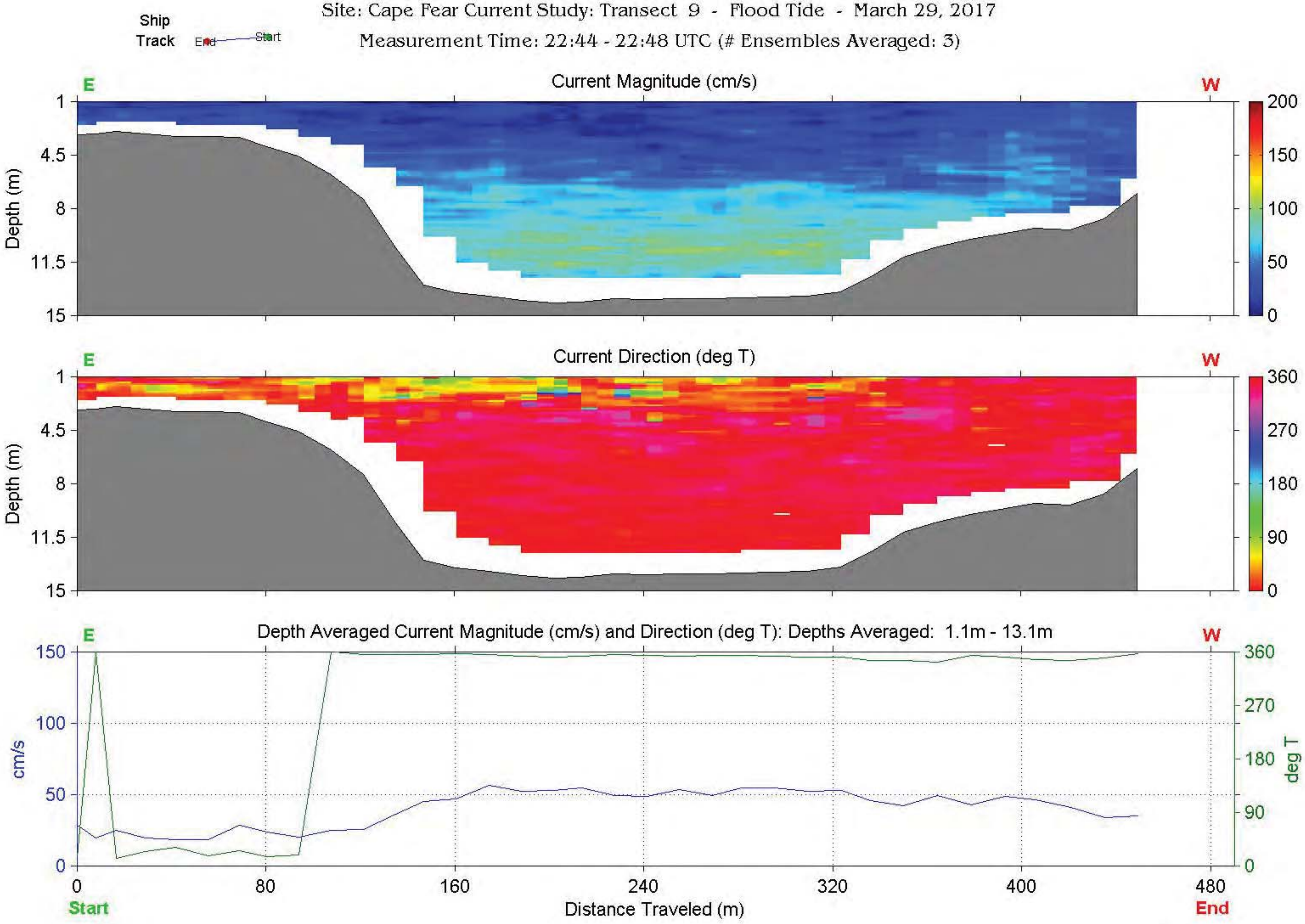
Measurement Time: 20:27 - 20:31 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 29, 2017

Measurement Time: 21:40 - 21:44 UTC (# Ensembles Averaged: 3)

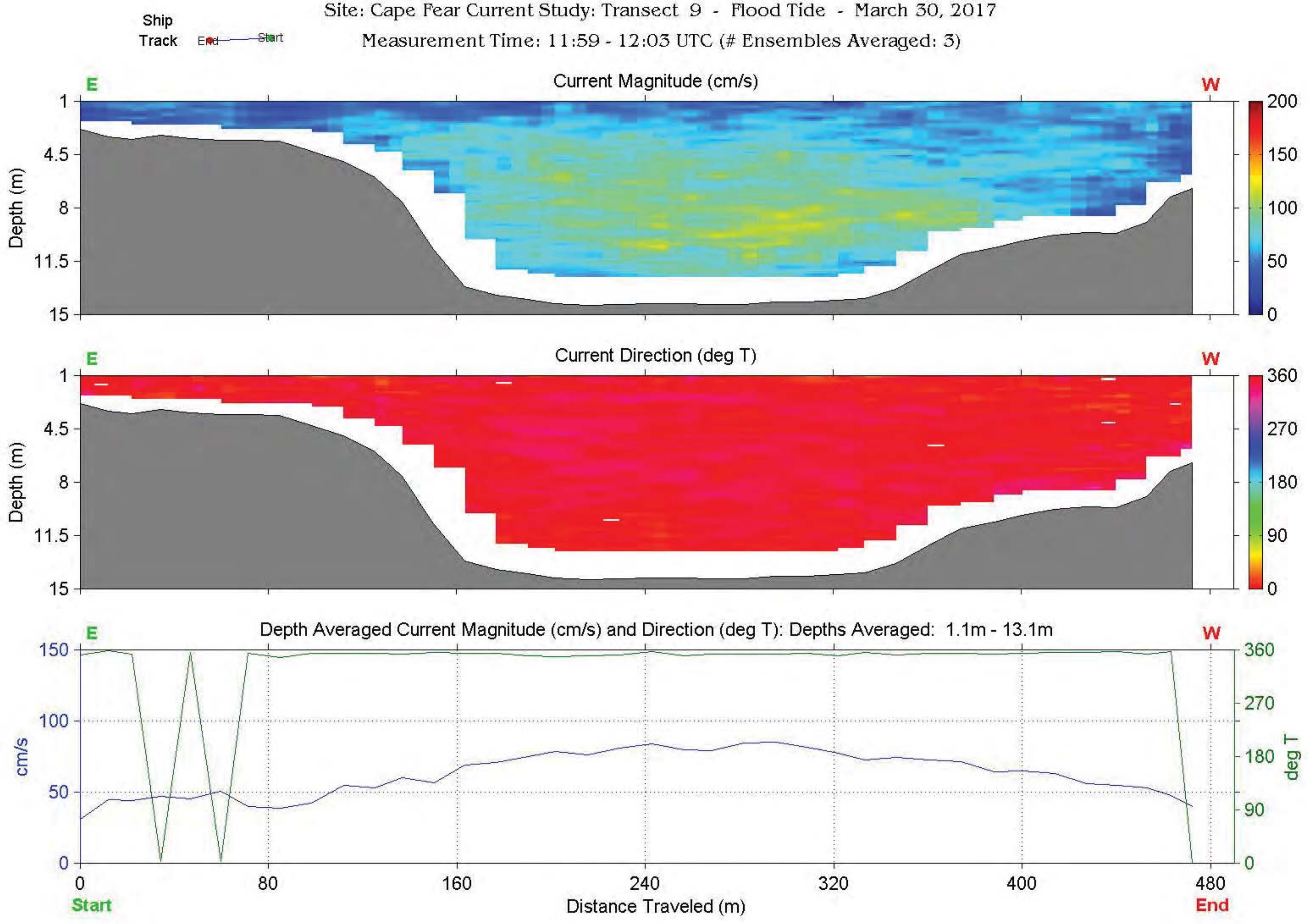


Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 29, 2017

Measurement Time: 22:44 - 22:48 UTC (# Ensembles Averaged: 3)

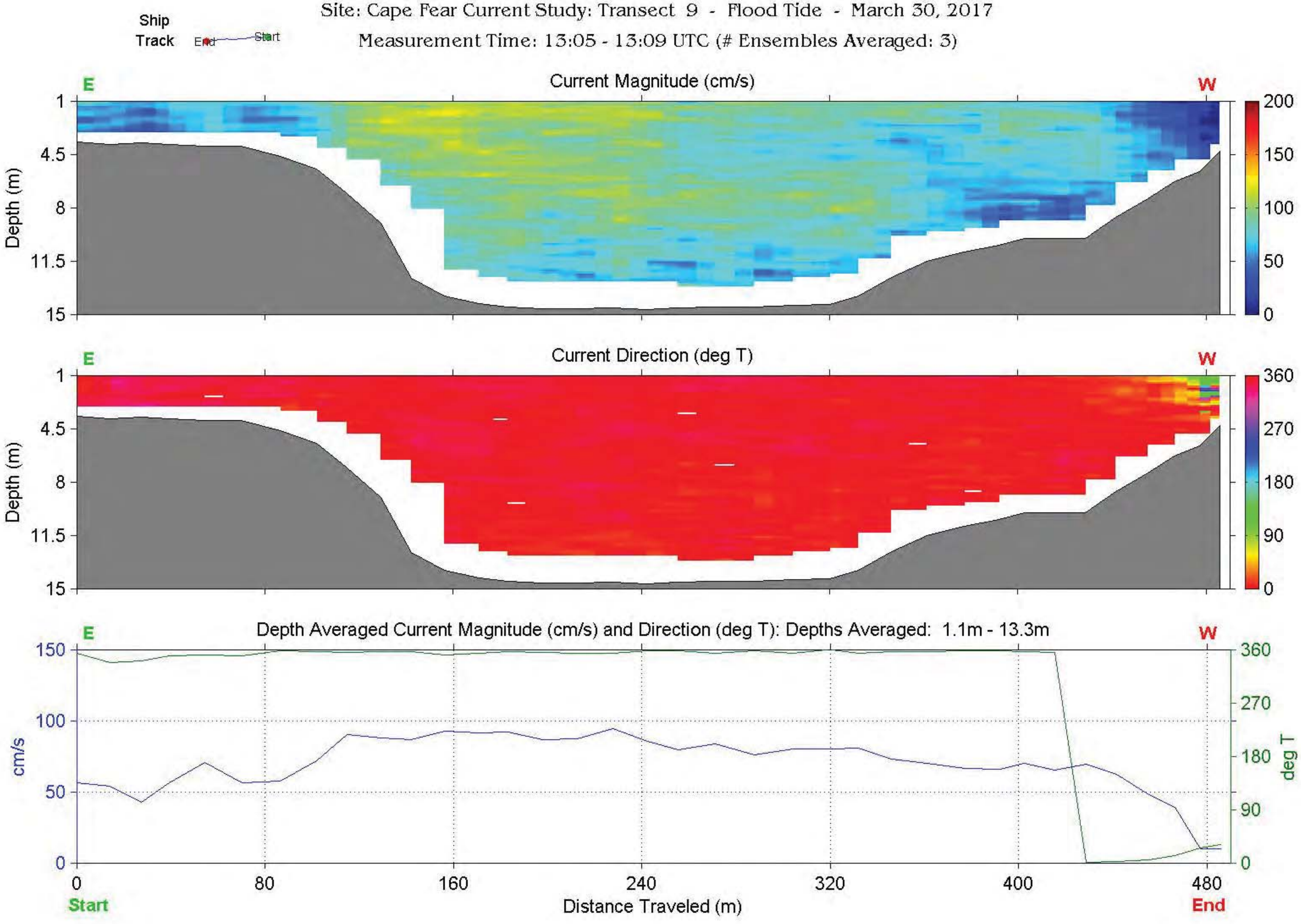
Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 30, 2017

Measurement Time: 11:59 - 12:03 UTC (# Ensembles Averaged: 3)



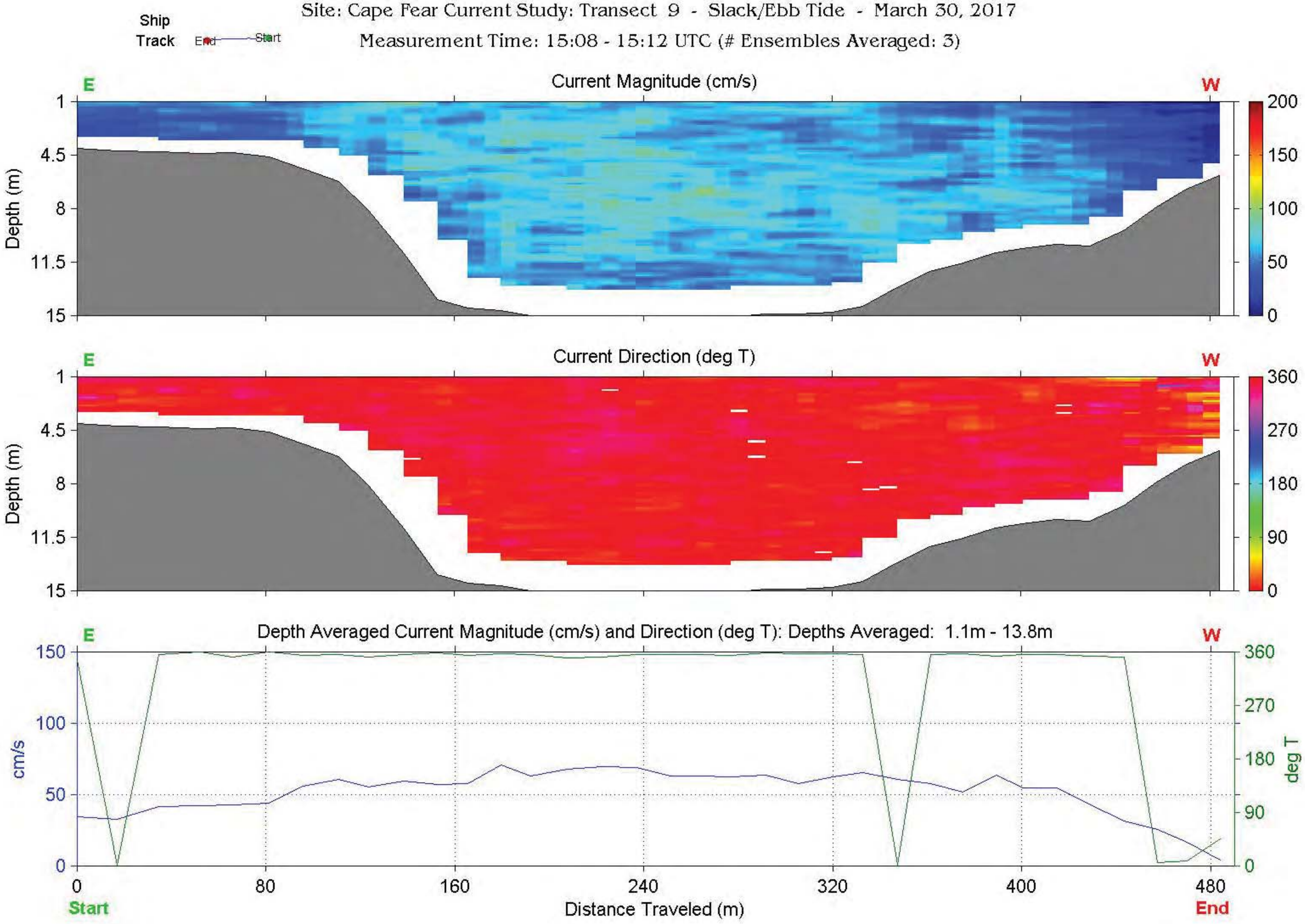
Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 30, 2017

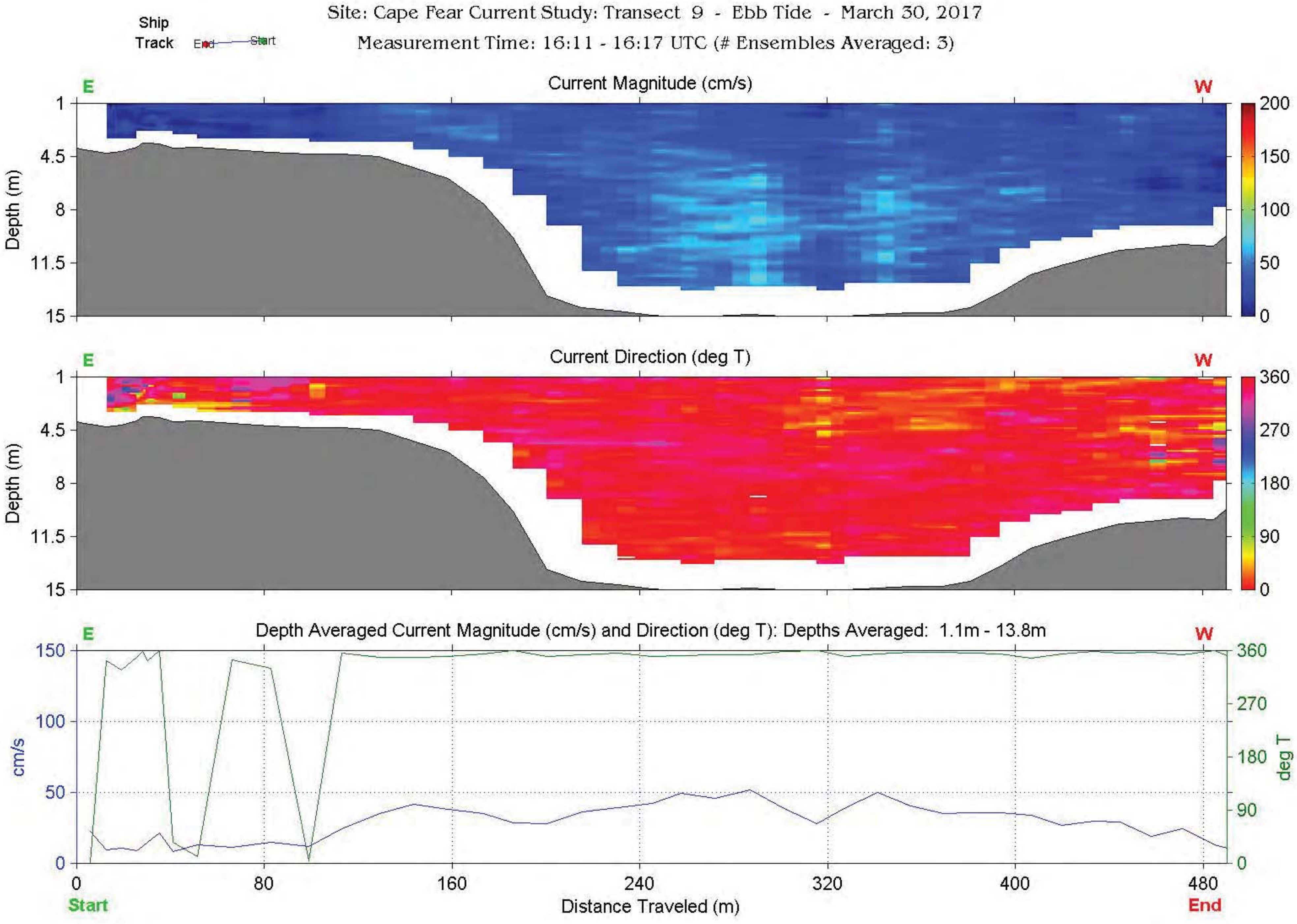
Measurement Time: 13:05 - 13:09 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 9 - Slack/Ebb Tide - March 30, 2017

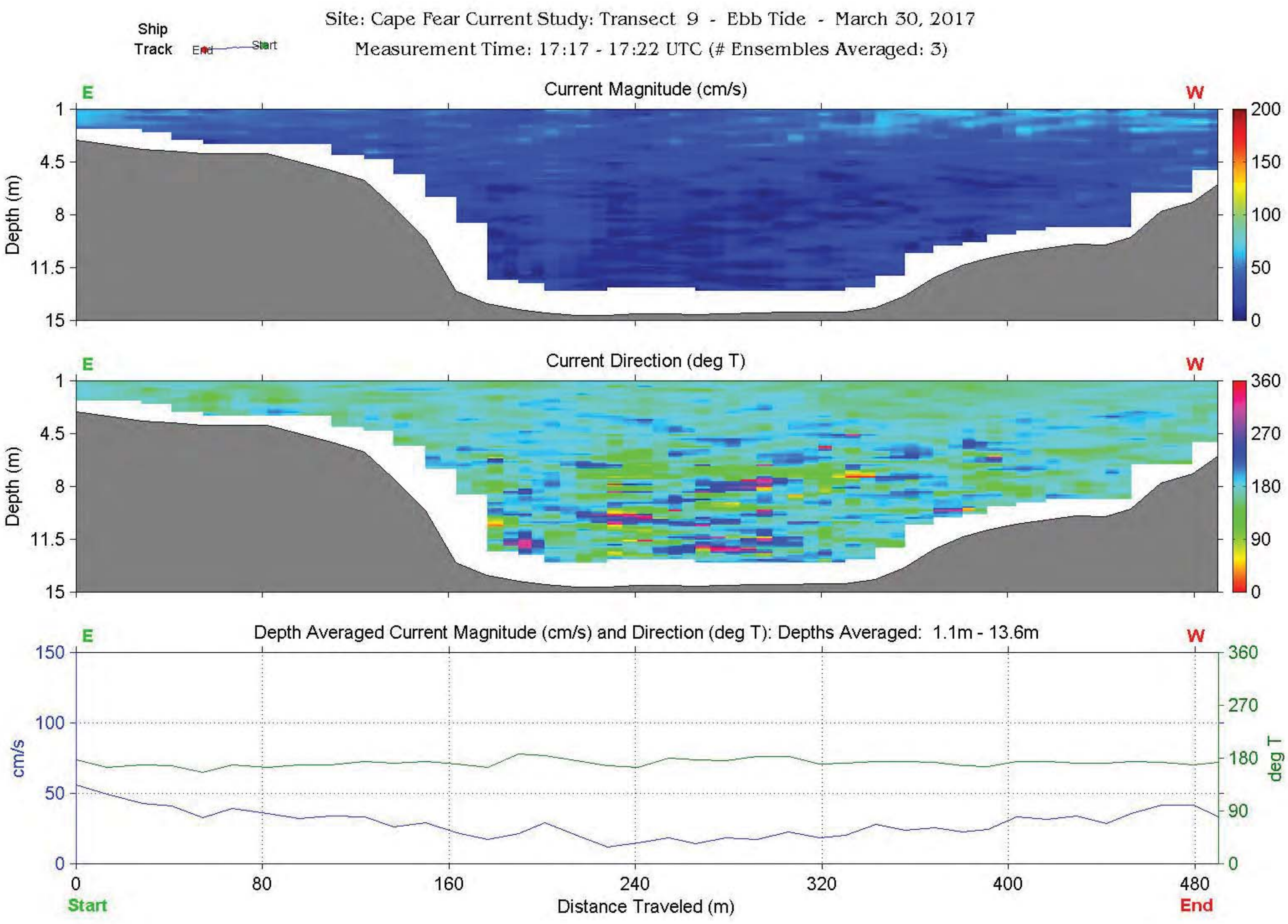
Measurement Time: 15:08 - 15:12 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 30, 2017

Measurement Time: 16:11 - 16:17 UTC (# Ensembles Averaged: 3)

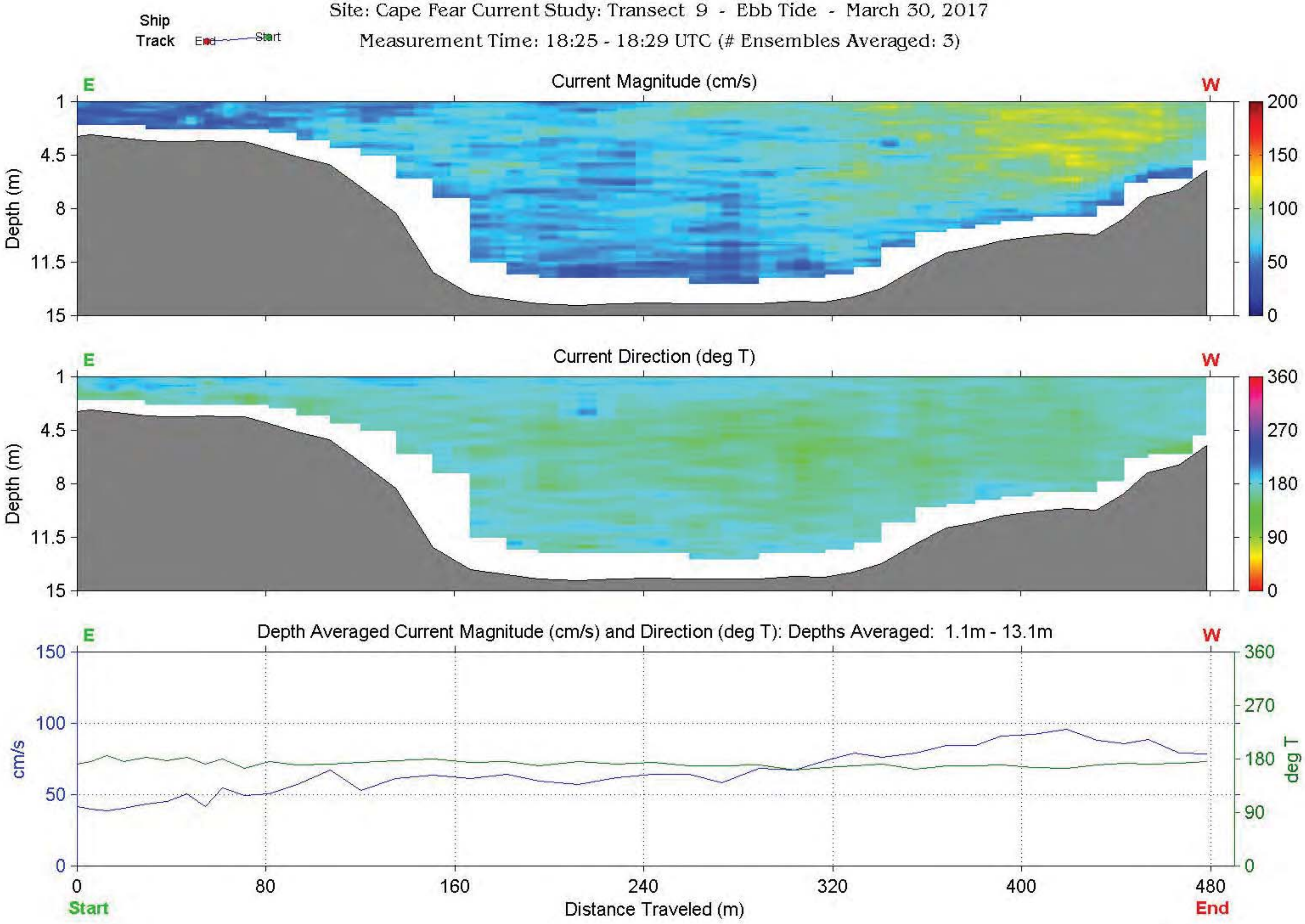


Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 30, 2017

Measurement Time: 17:17 - 17:22 UTC (# Ensembles Averaged: 3)

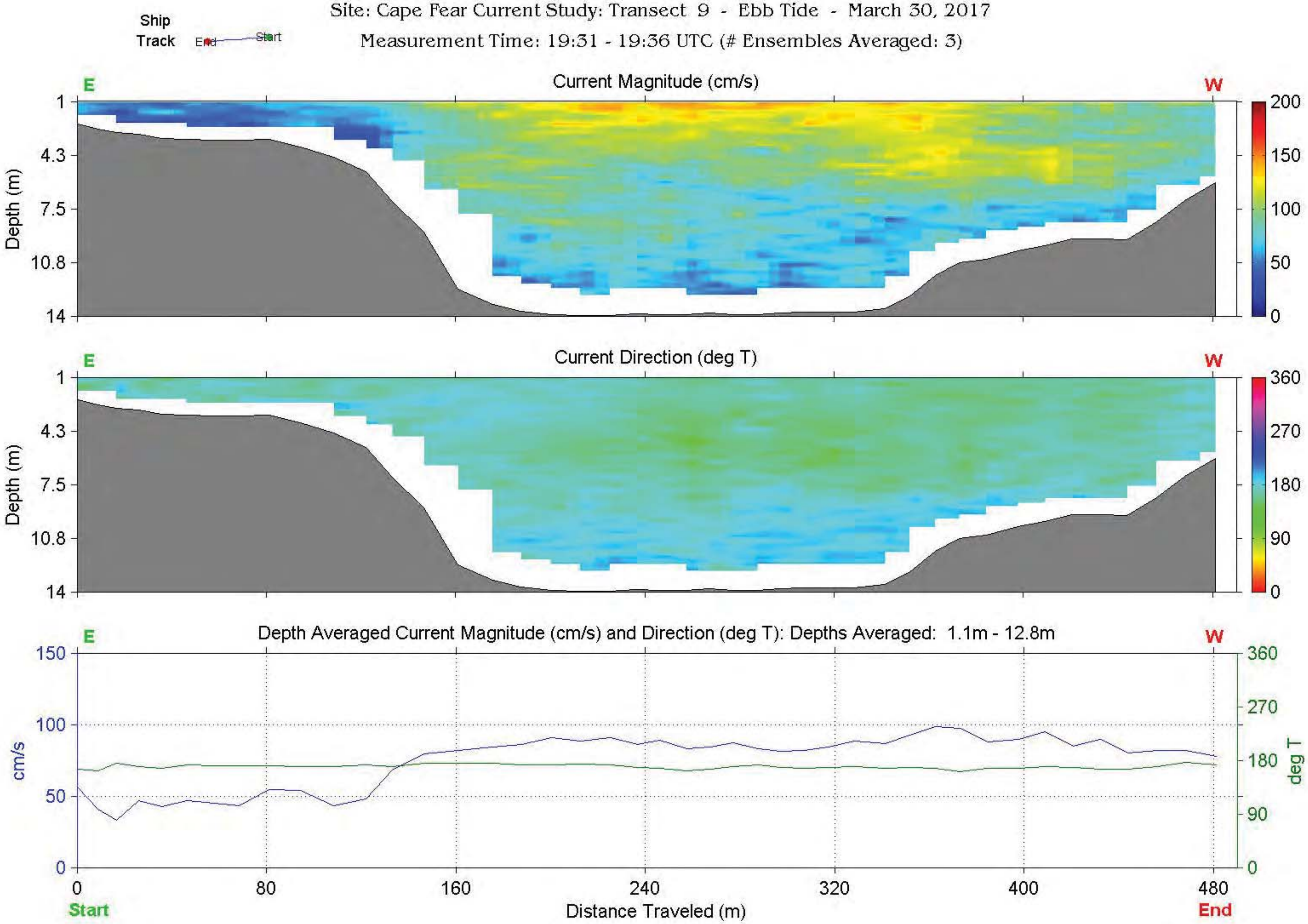
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 30, 2017

Measurement Time: 18:25 - 18:29 UTC (# Ensembles Averaged: 3)



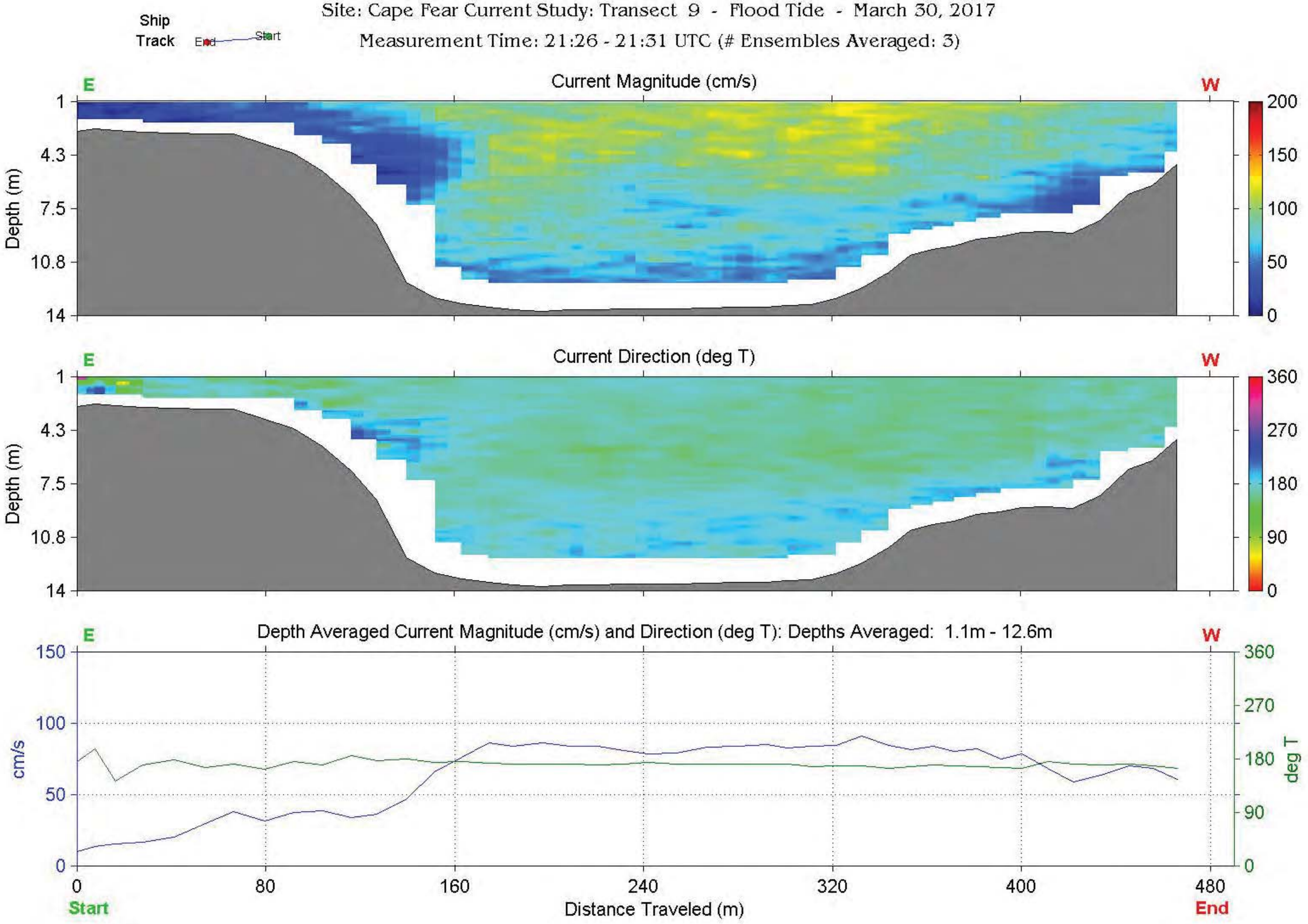
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 30, 2017

Measurement Time: 19:31 - 19:36 UTC (# Ensembles Averaged: 3)



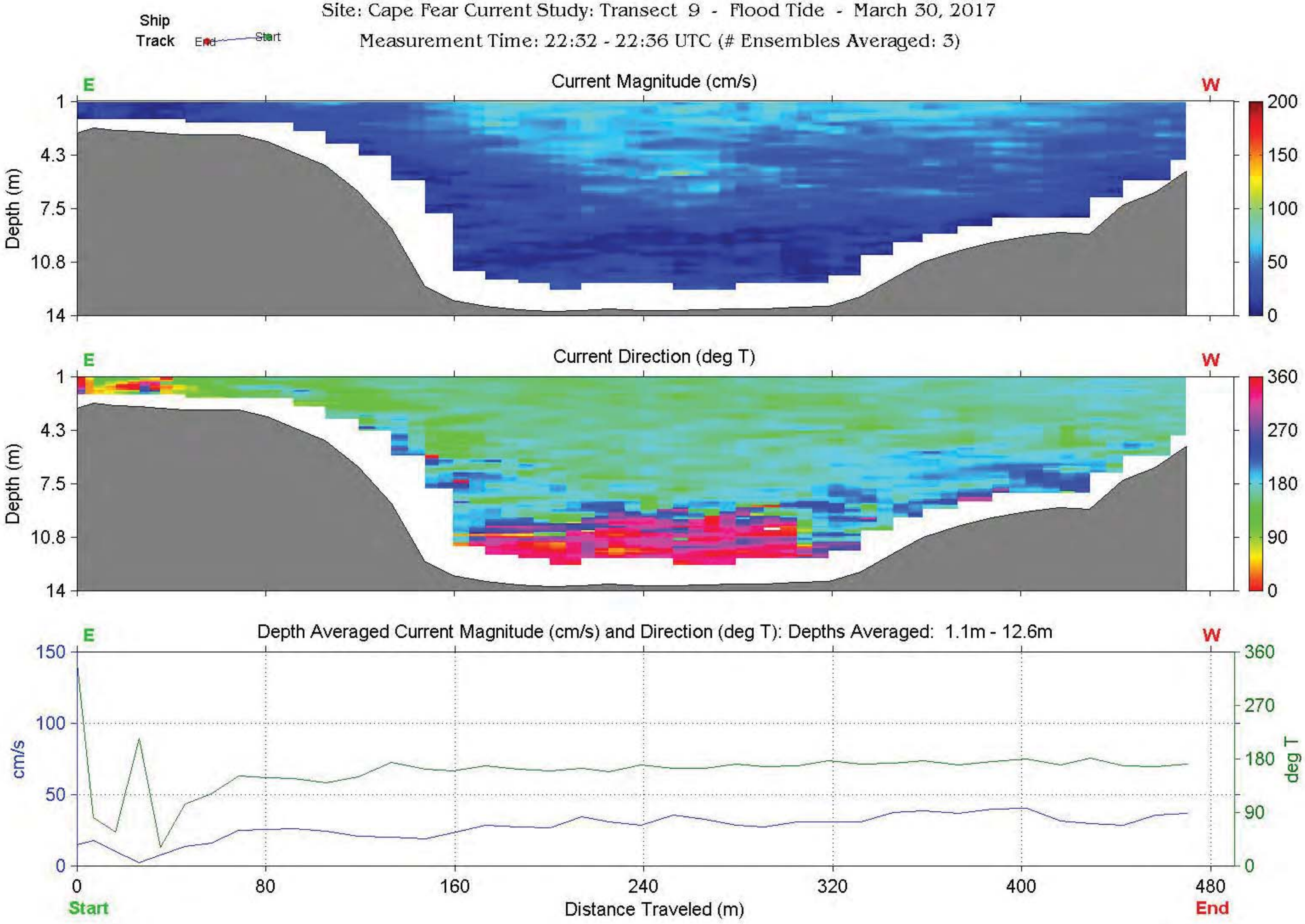
Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 30, 2017

Measurement Time: 21:26 - 21:31 UTC (# Ensembles Averaged: 3)



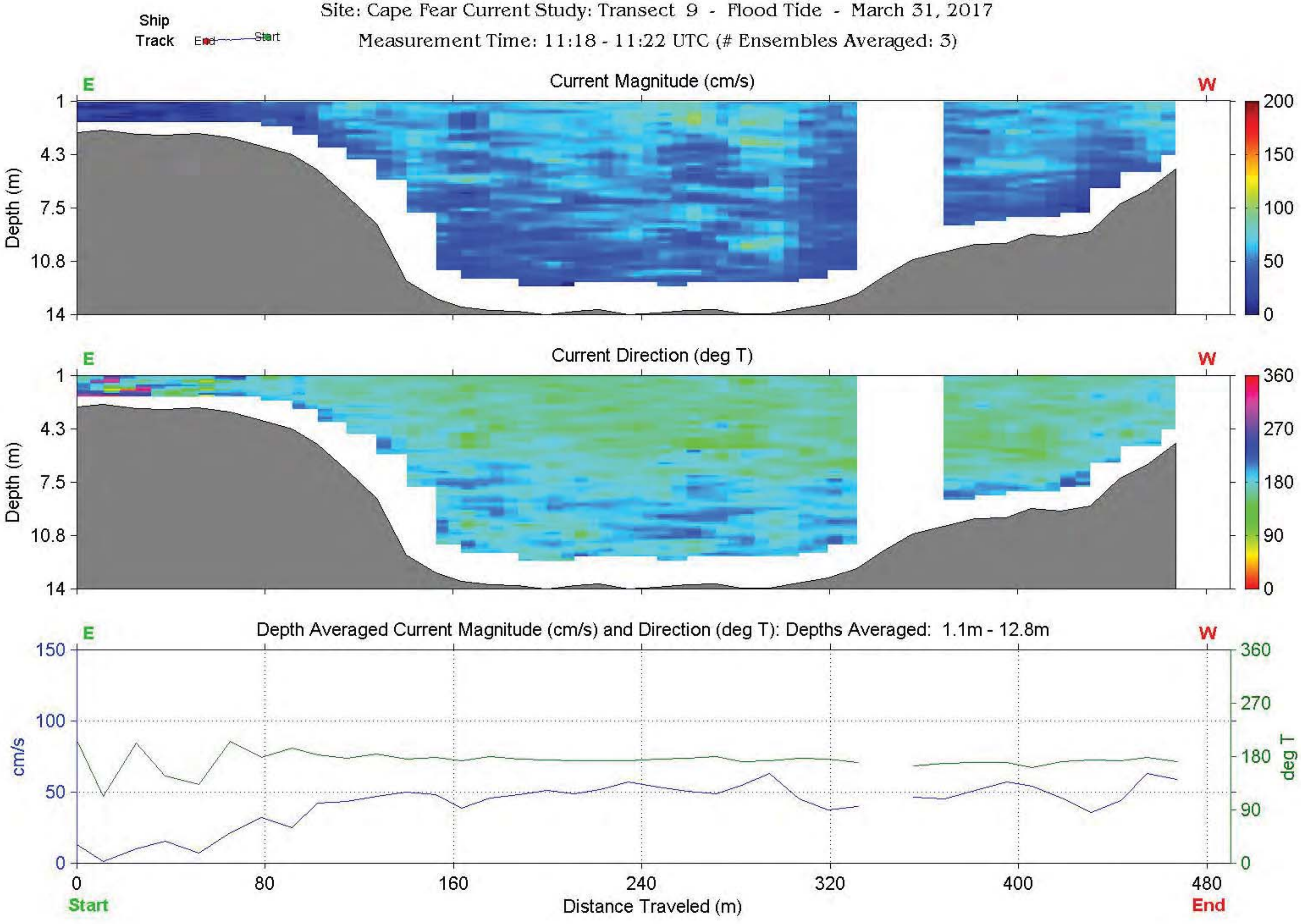
Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 30, 2017

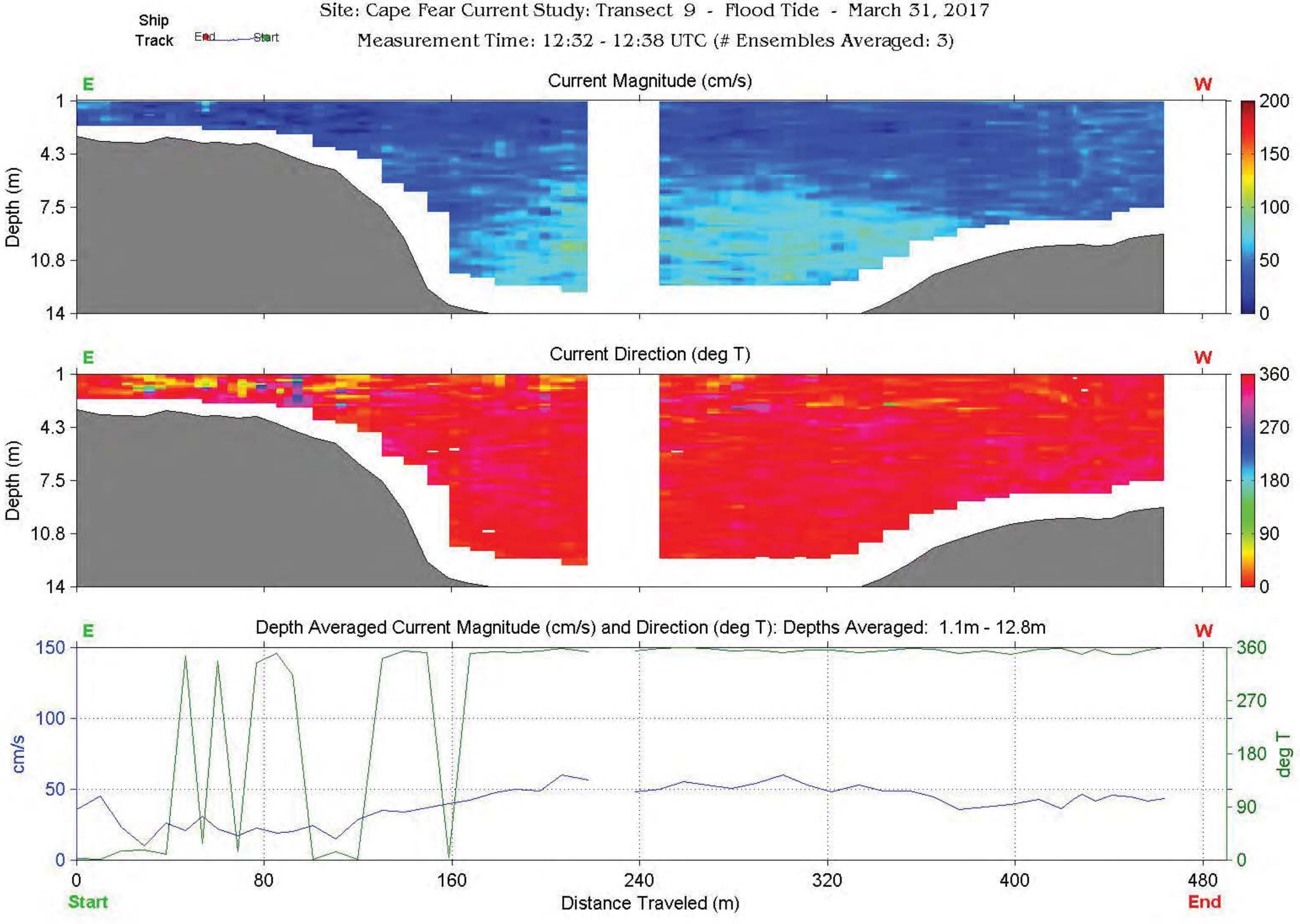
Measurement Time: 22:32 - 22:36 UTC (# Ensembles Averaged: 3)



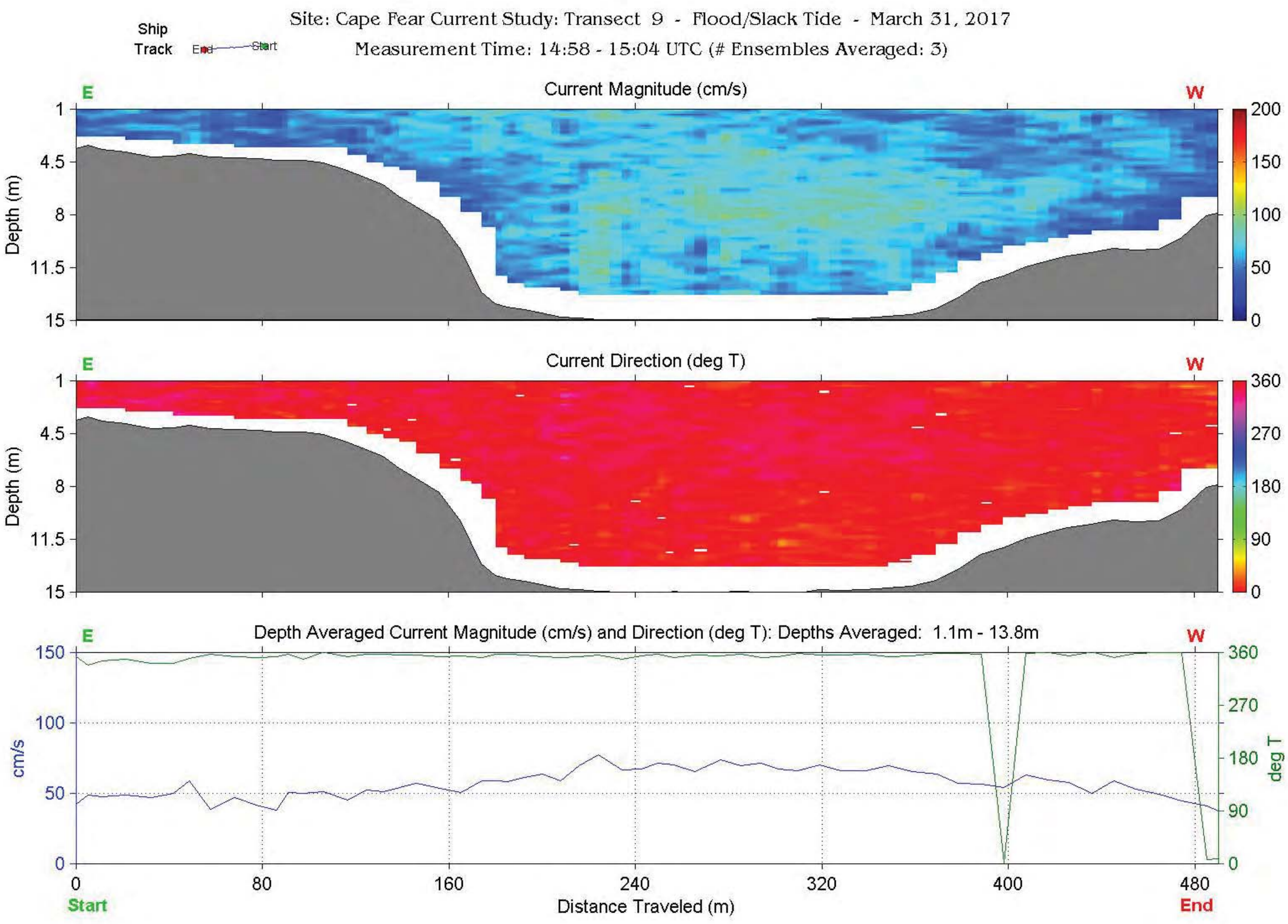
Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 31, 2017

Measurement Time: 11:18 - 11:22 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 9 - Flood Tide - March 31, 2017

Measurement Time: 12:32 - 12:38 UTC (# Ensembles Averaged: 3)

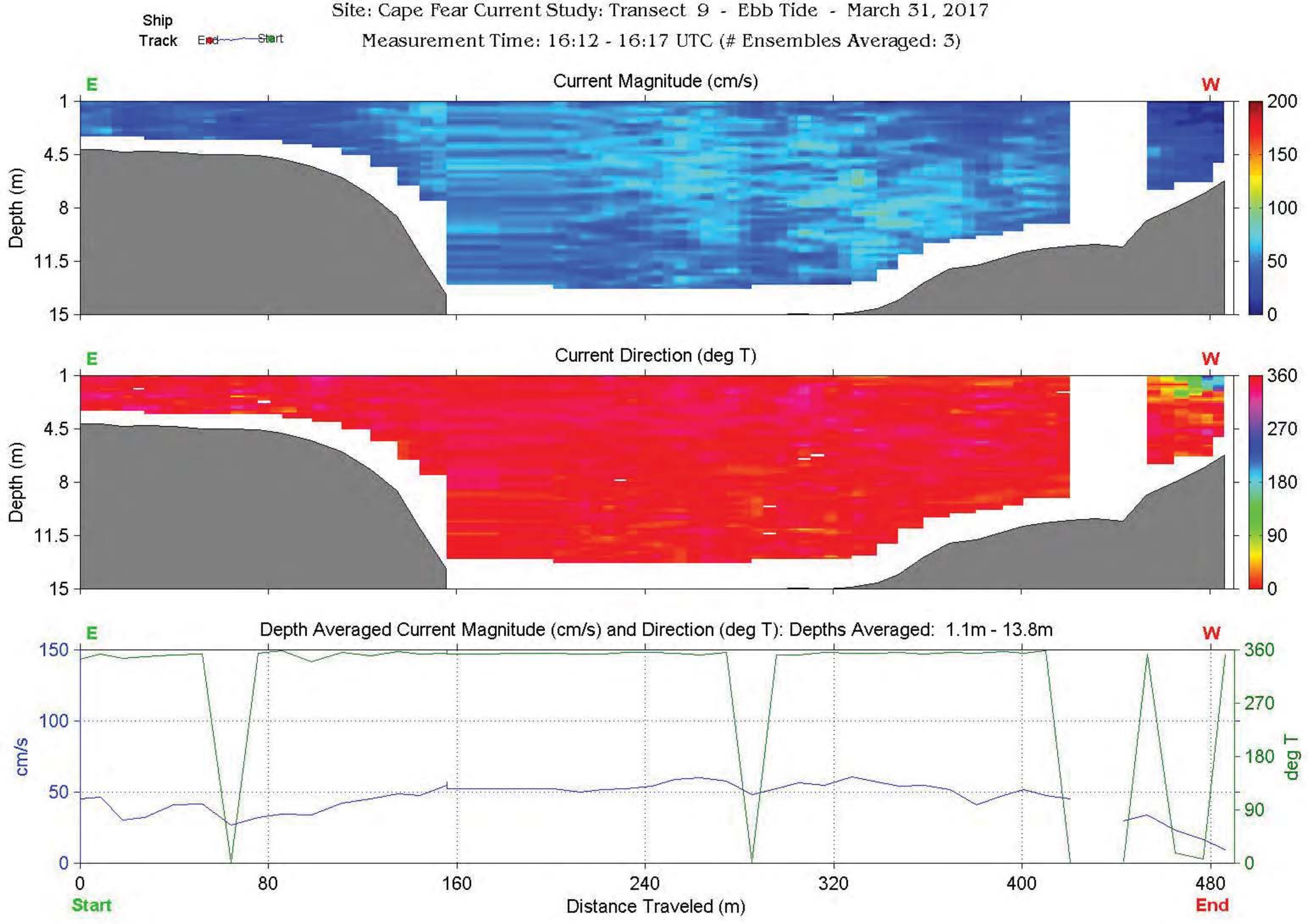


Site: Cape Fear Current Study: Transect 9 - Flood/Slack Tide - March 31, 2017

Measurement Time: 14:58 - 15:04 UTC (# Ensembles Averaged: 3)

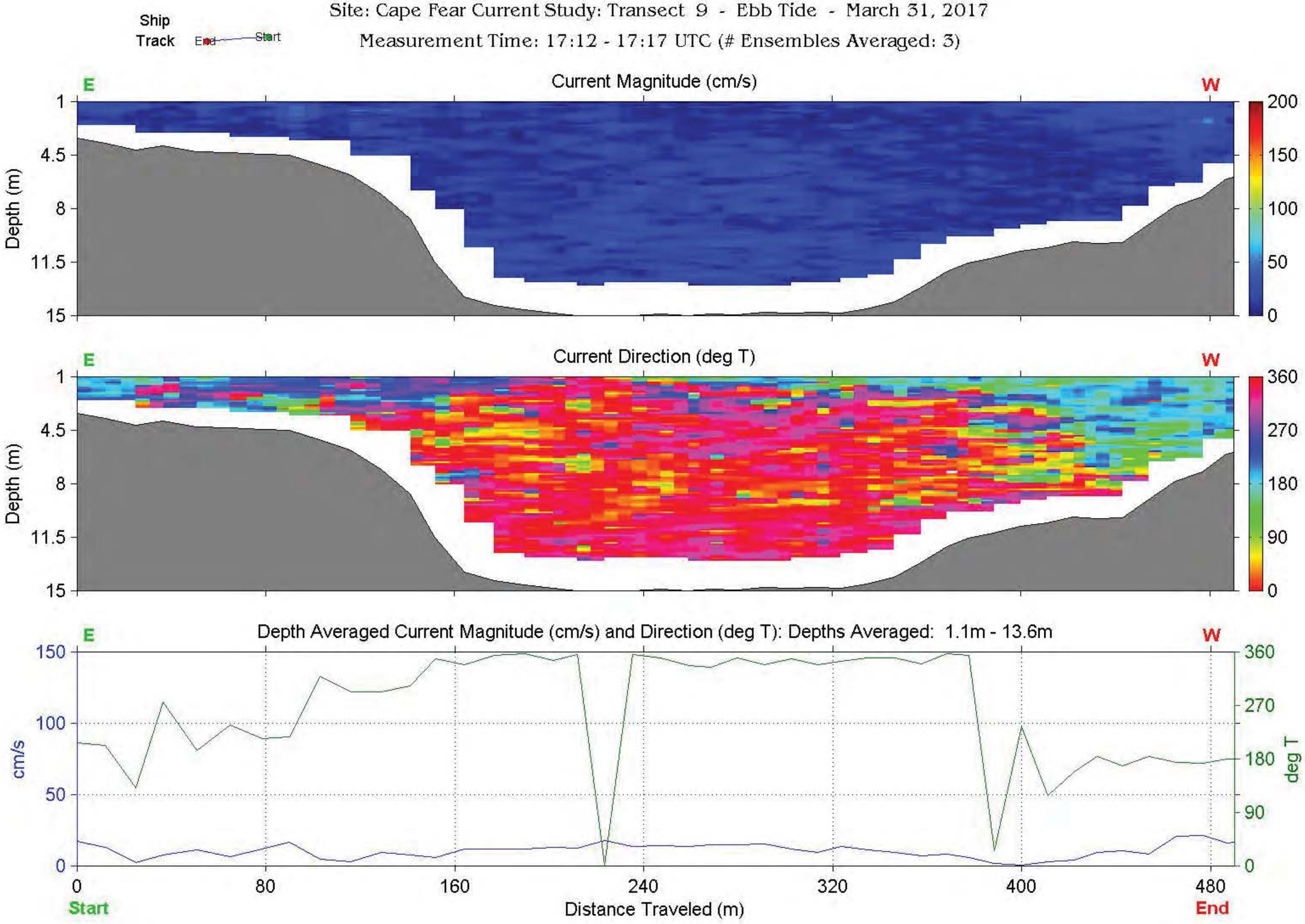
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 31, 2017

Measurement Time: 16:12 - 16:17 UTC (# Ensembles Averaged: 3)



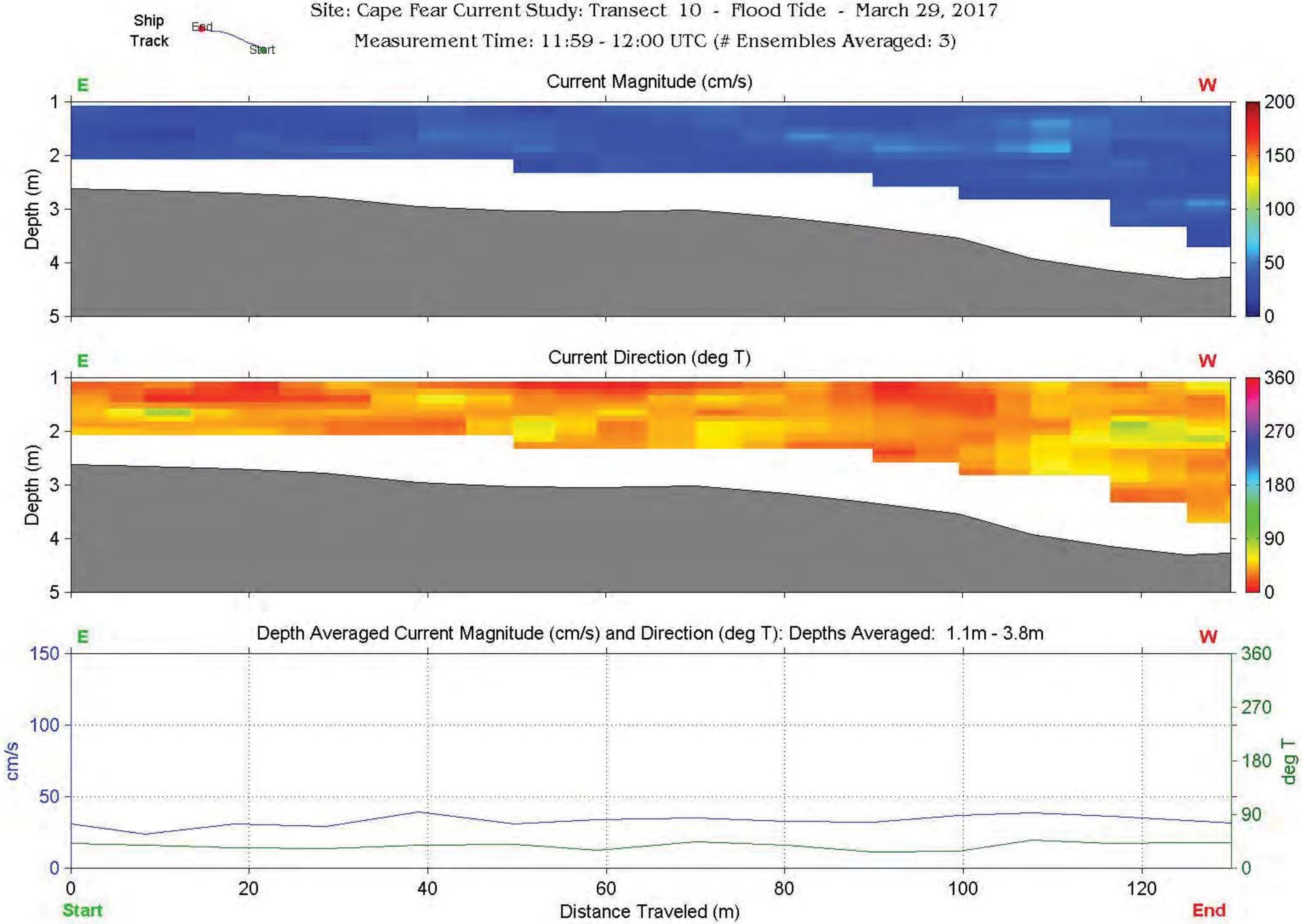
Site: Cape Fear Current Study: Transect 9 - Ebb Tide - March 31, 2017

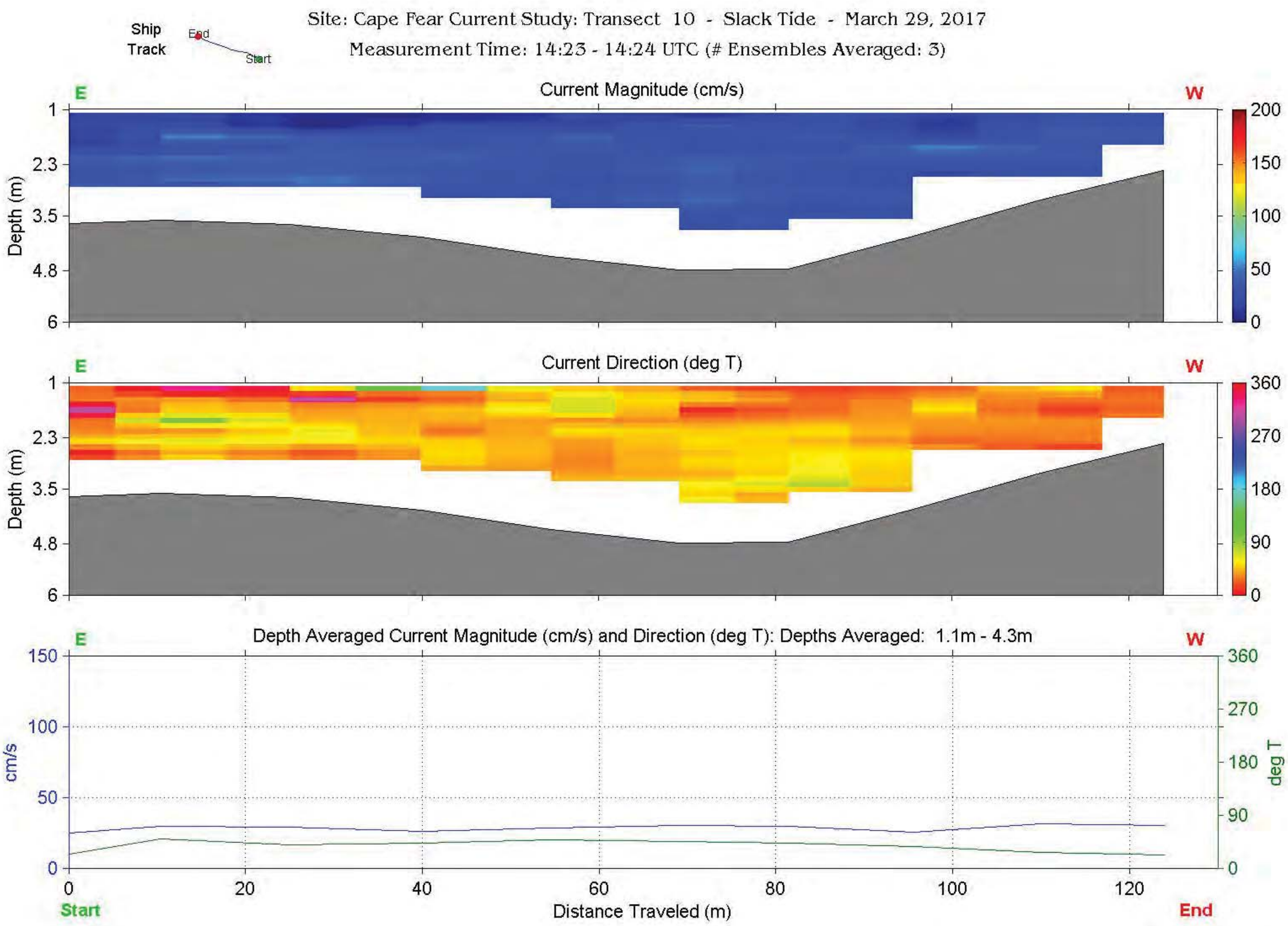
Measurement Time: 17:12 - 17:17 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 29, 2017

Measurement Time: 11:59 - 12:00 UTC (# Ensembles Averaged: 3)



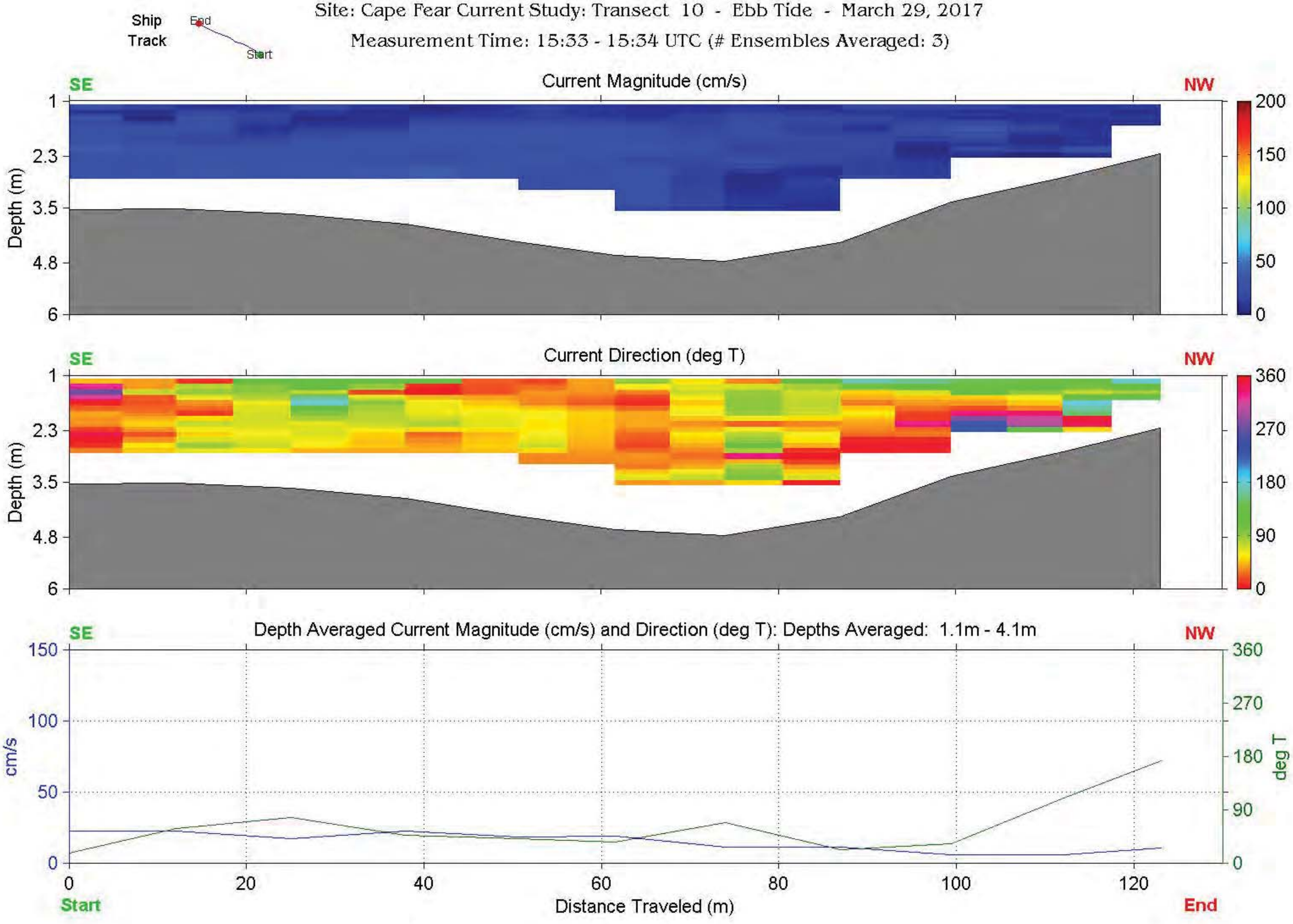


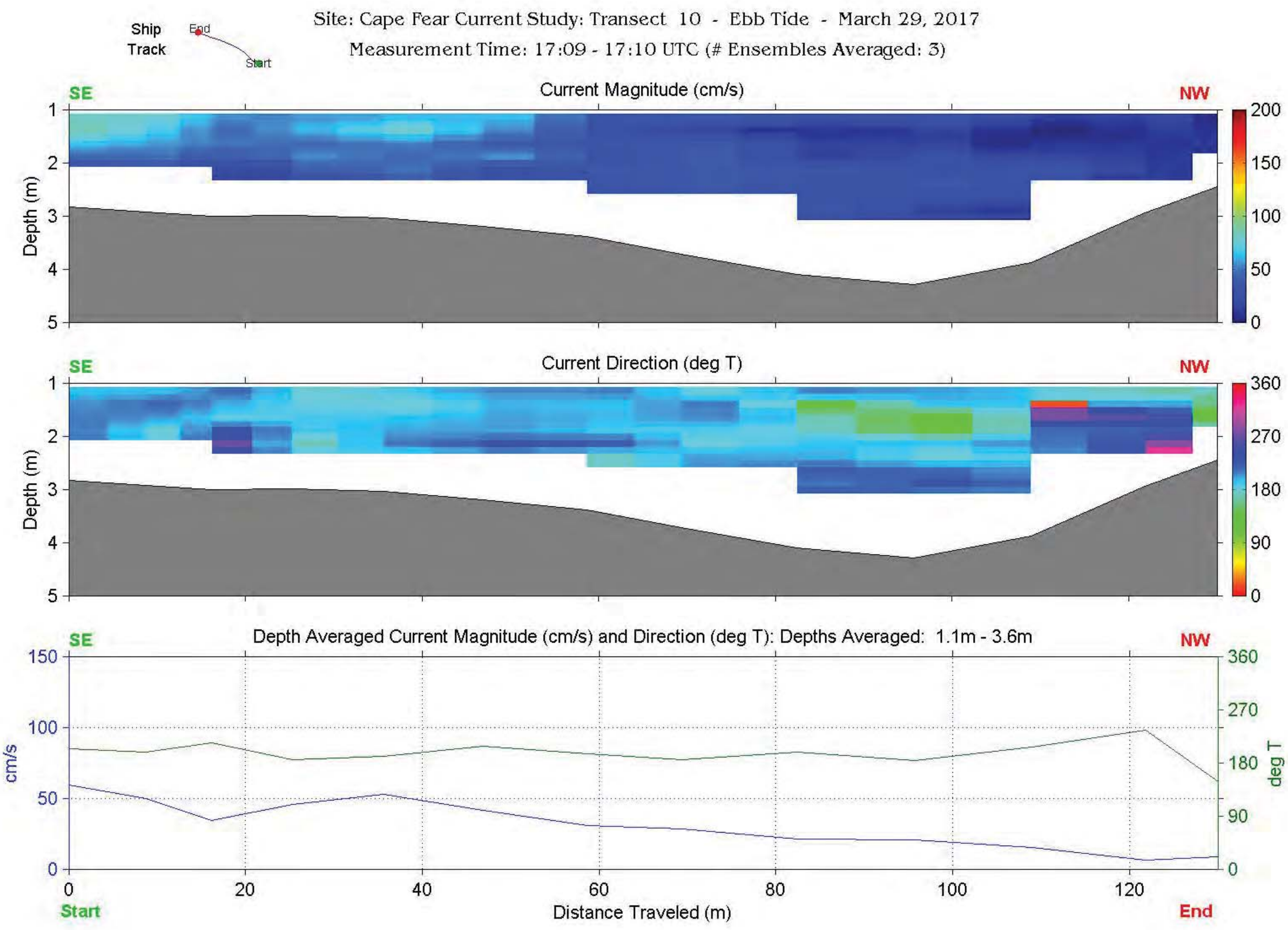
Site: Cape Fear Current Study: Transect 10 - Slack Tide - March 29, 2017

Measurement Time: 14:23 - 14:24 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 29, 2017

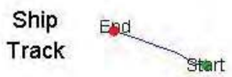
Measurement Time: 15:33 - 15:34 UTC (# Ensembles Averaged: 3)

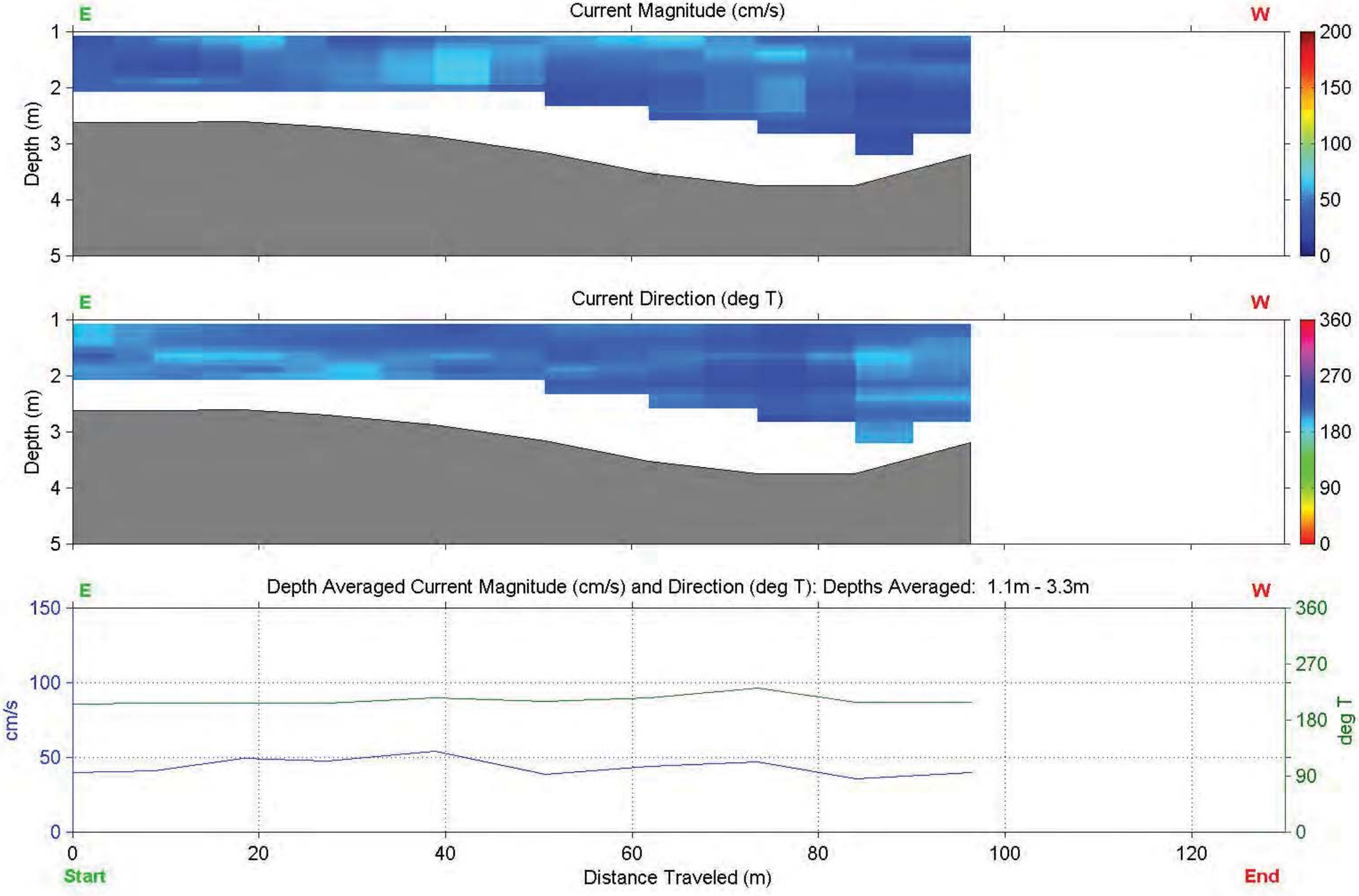


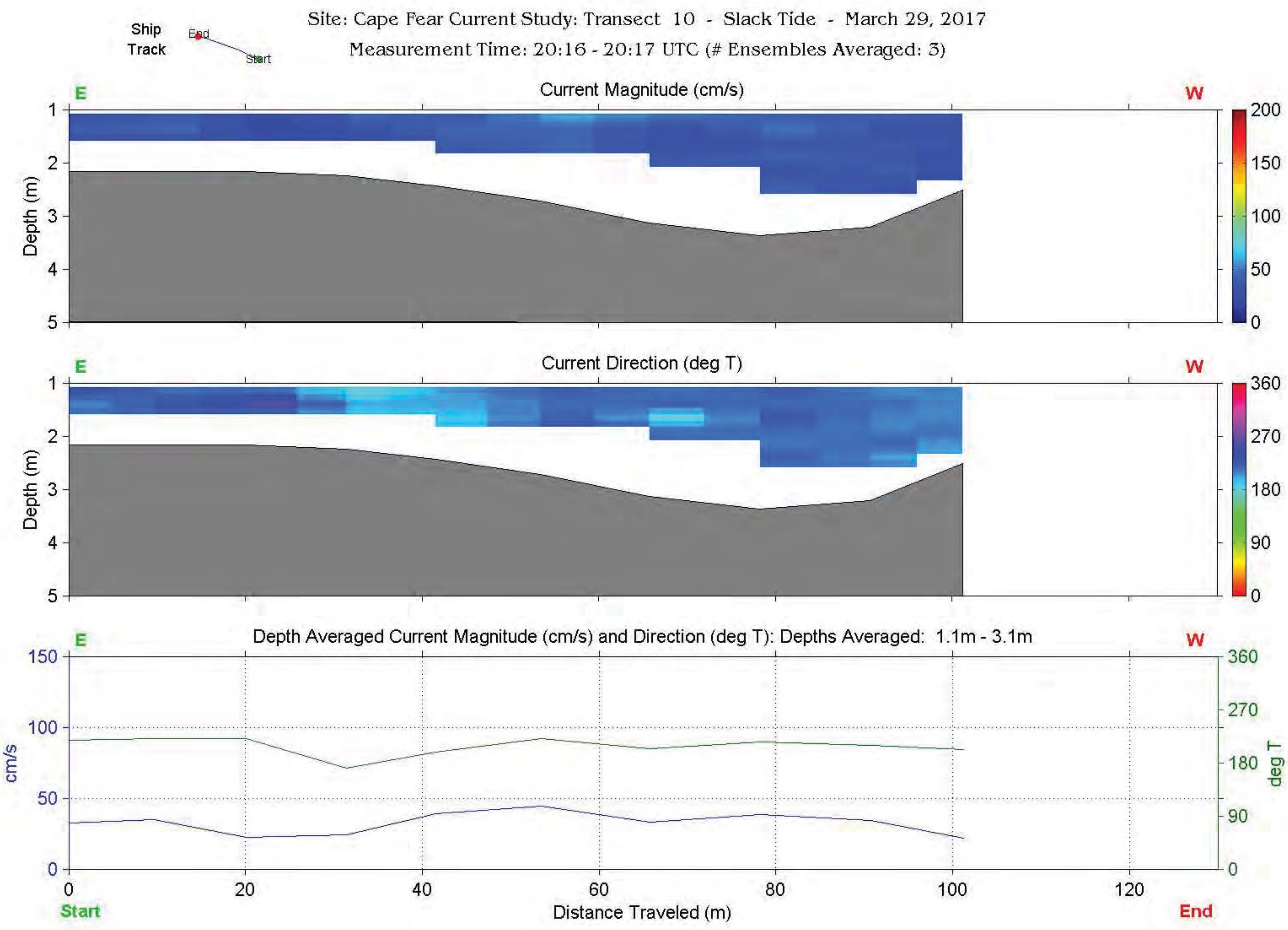

Ship
Track
End
Start
Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 29, 2017
Measurement Time: 17:09 - 17:10 UTC (# Ensembles Averaged: 3)
SE
Current Magnitude (cm/s)
NW
Depth (m)
1
2
3
4
5
200
150
100
50
0
SE
Current Direction (deg T)
NW
Depth (m)
1
2
3
4
5
360
270
180
90
0
SE
Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.1m - 3.6m
NW
cm/s
150
100
50
0
deg T
360
270
180
90
0
0
20
40
60
80
100
120
Start
Distance Traveled (m)
End

Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 29, 2017

Measurement Time: 18:27 - 18:28 UTC (# Ensembles Averaged: 3)





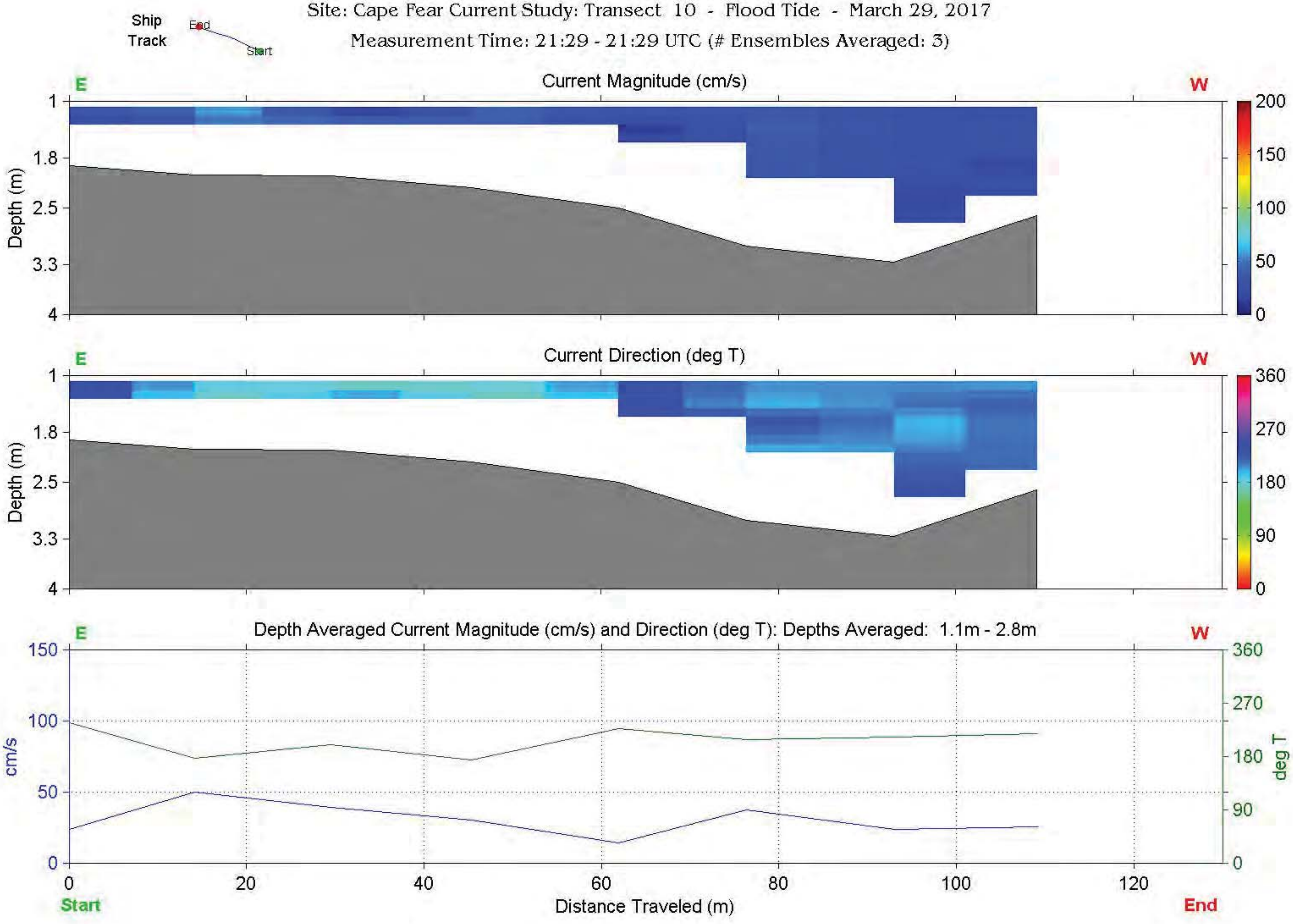


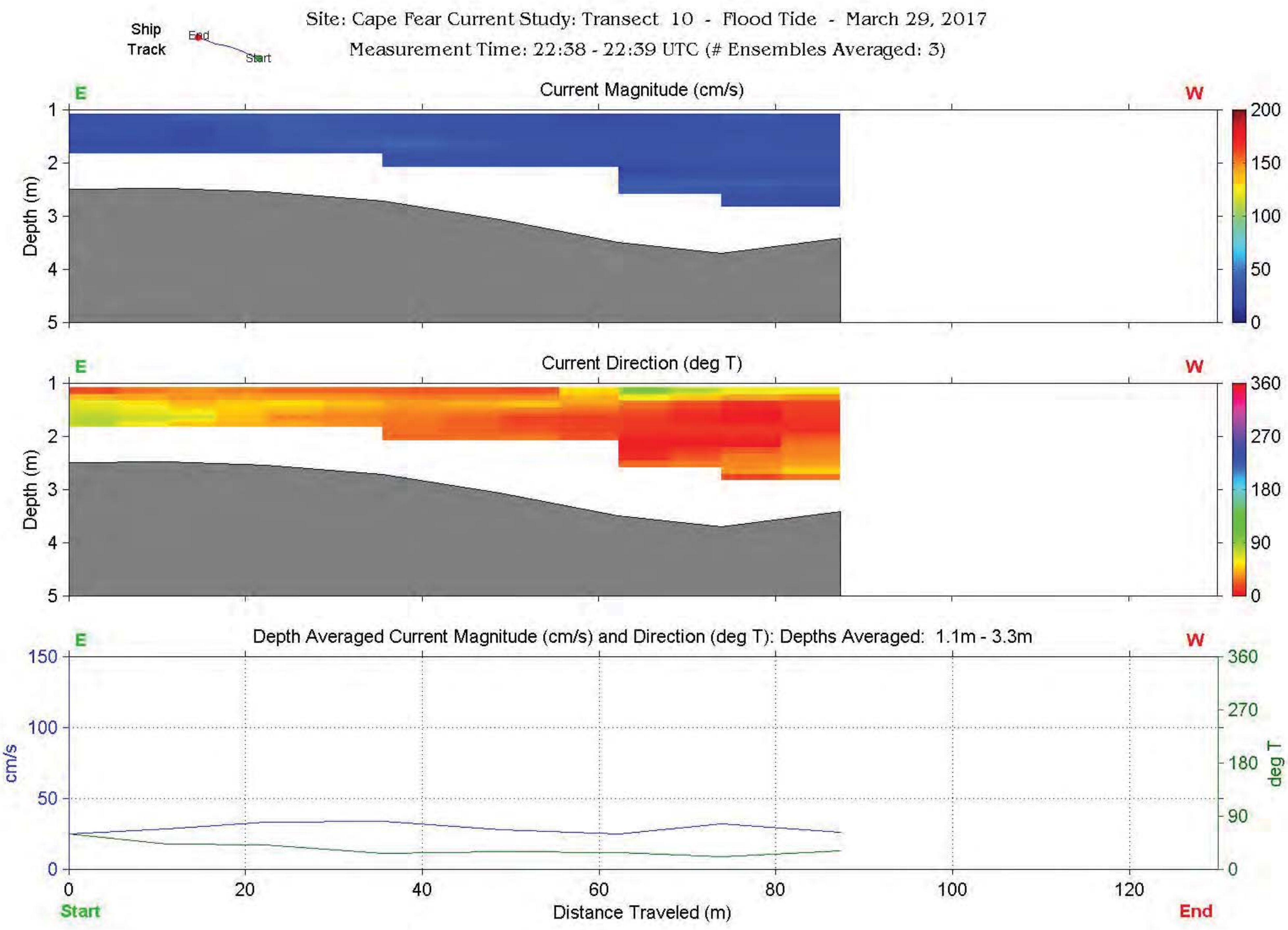
Site: Cape Fear Current Study: Transect 10 - Slack Tide - March 29, 2017

Measurement Time: 20:16 - 20:17 UTC (# Ensembles Averaged: 3)

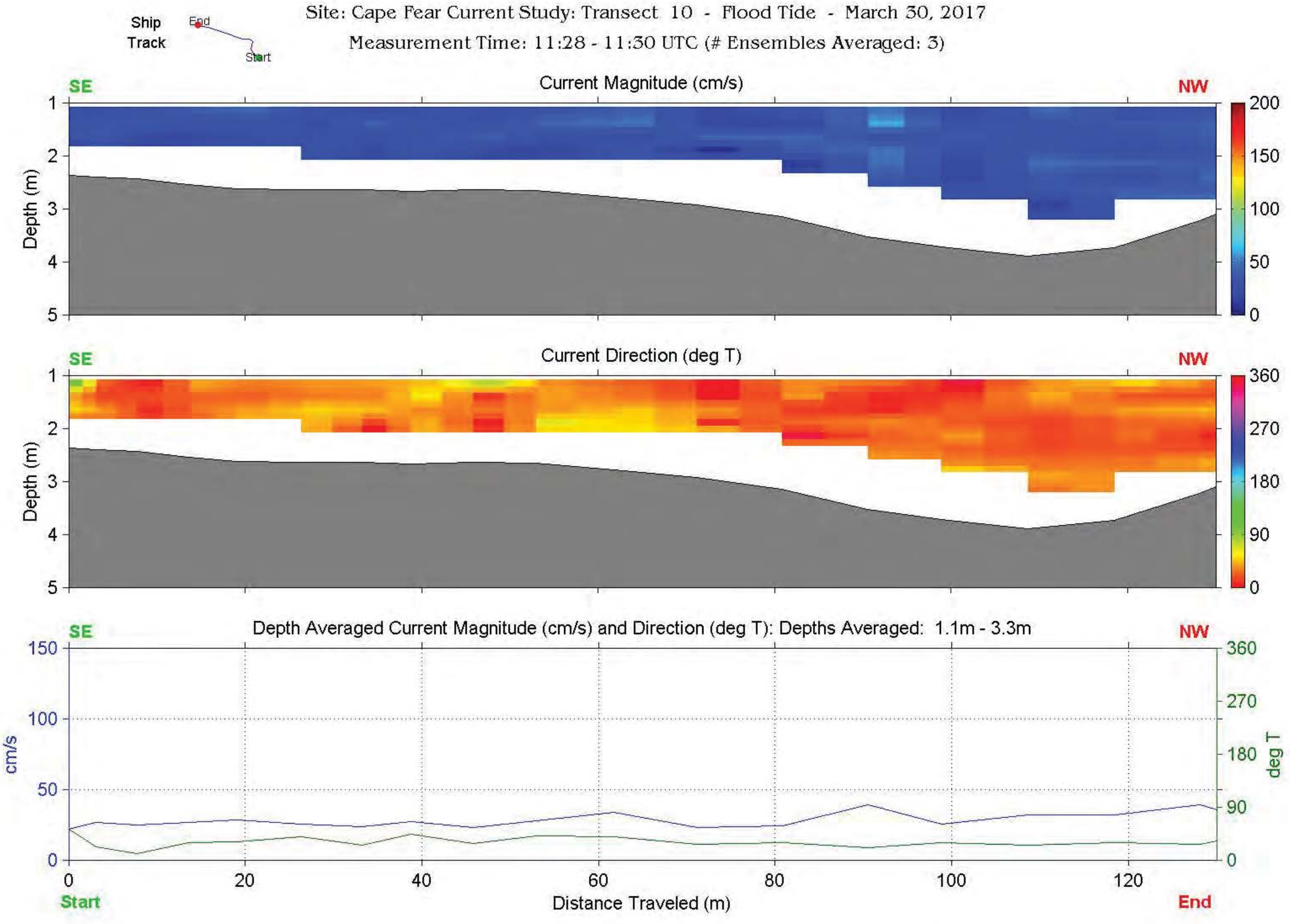
Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 29, 2017

Measurement Time: 21:29 - 21:29 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 29, 2017

Measurement Time: 22:38 - 22:39 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 30, 2017

Measurement Time: 11:28 - 11:30 UTC (# Ensembles Averaged: 3)

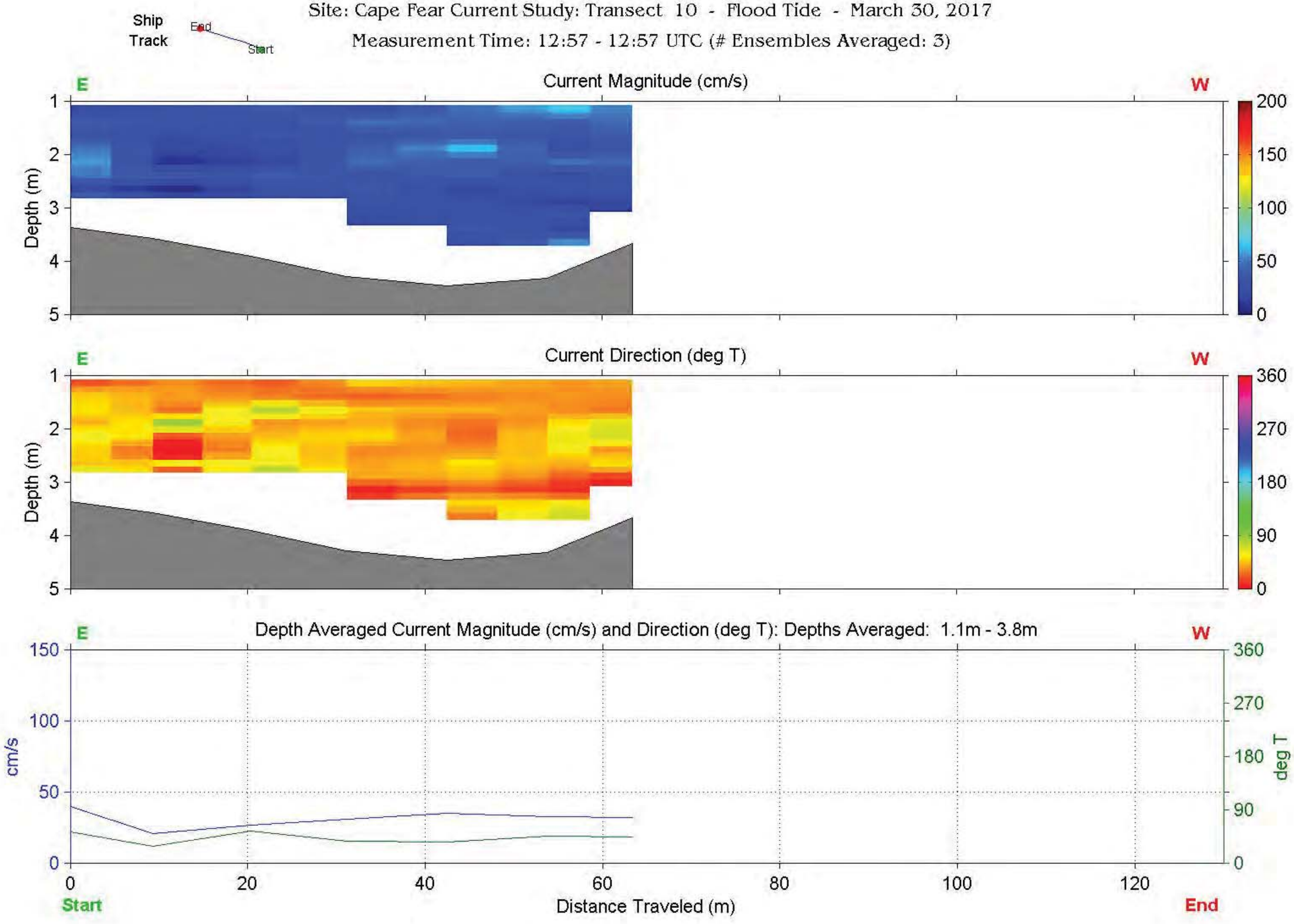
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.1m - 3.3m

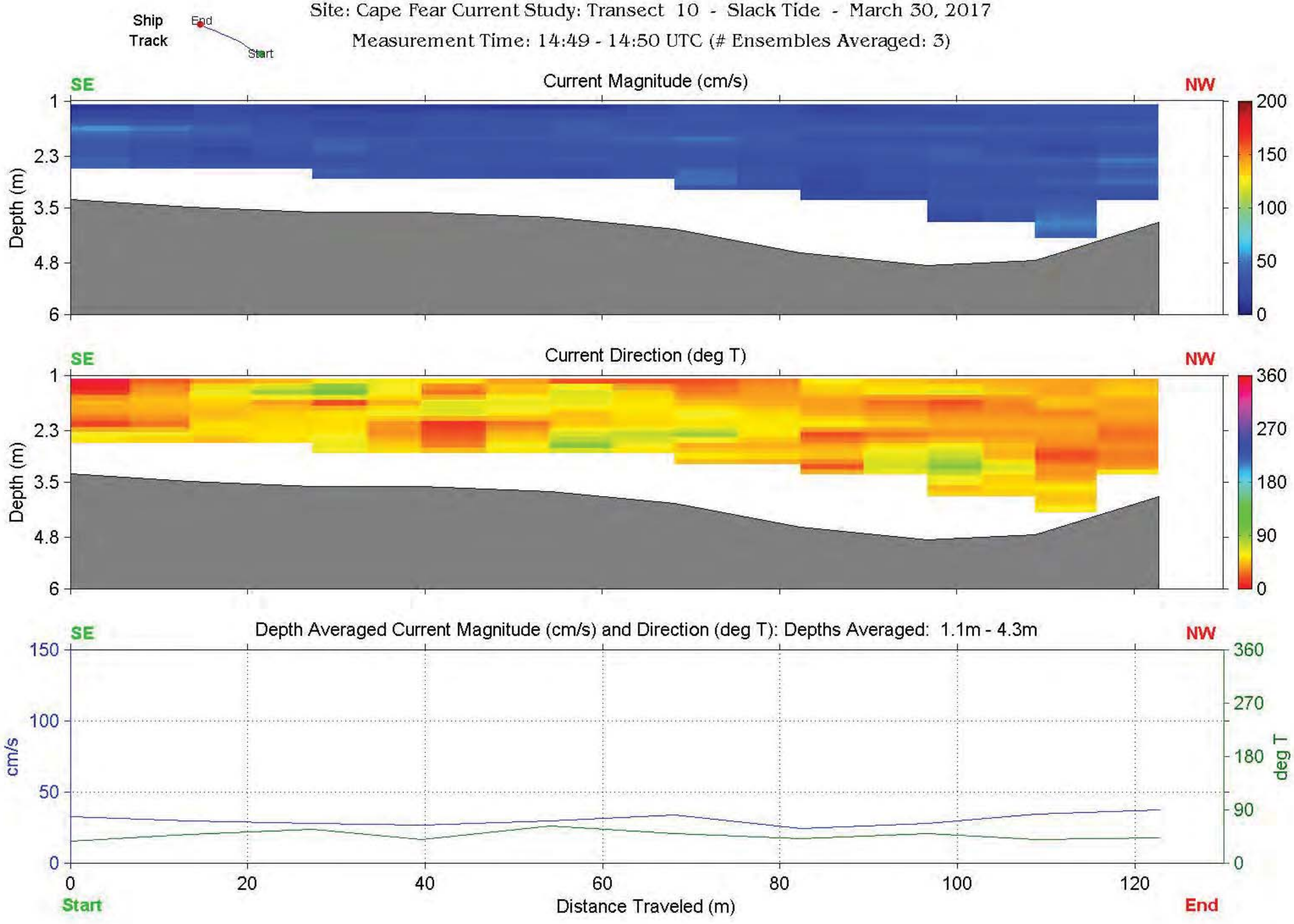
Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 30, 2017

Measurement Time: 12:57 - 12:57 UTC (# Ensembles Averaged: 3)



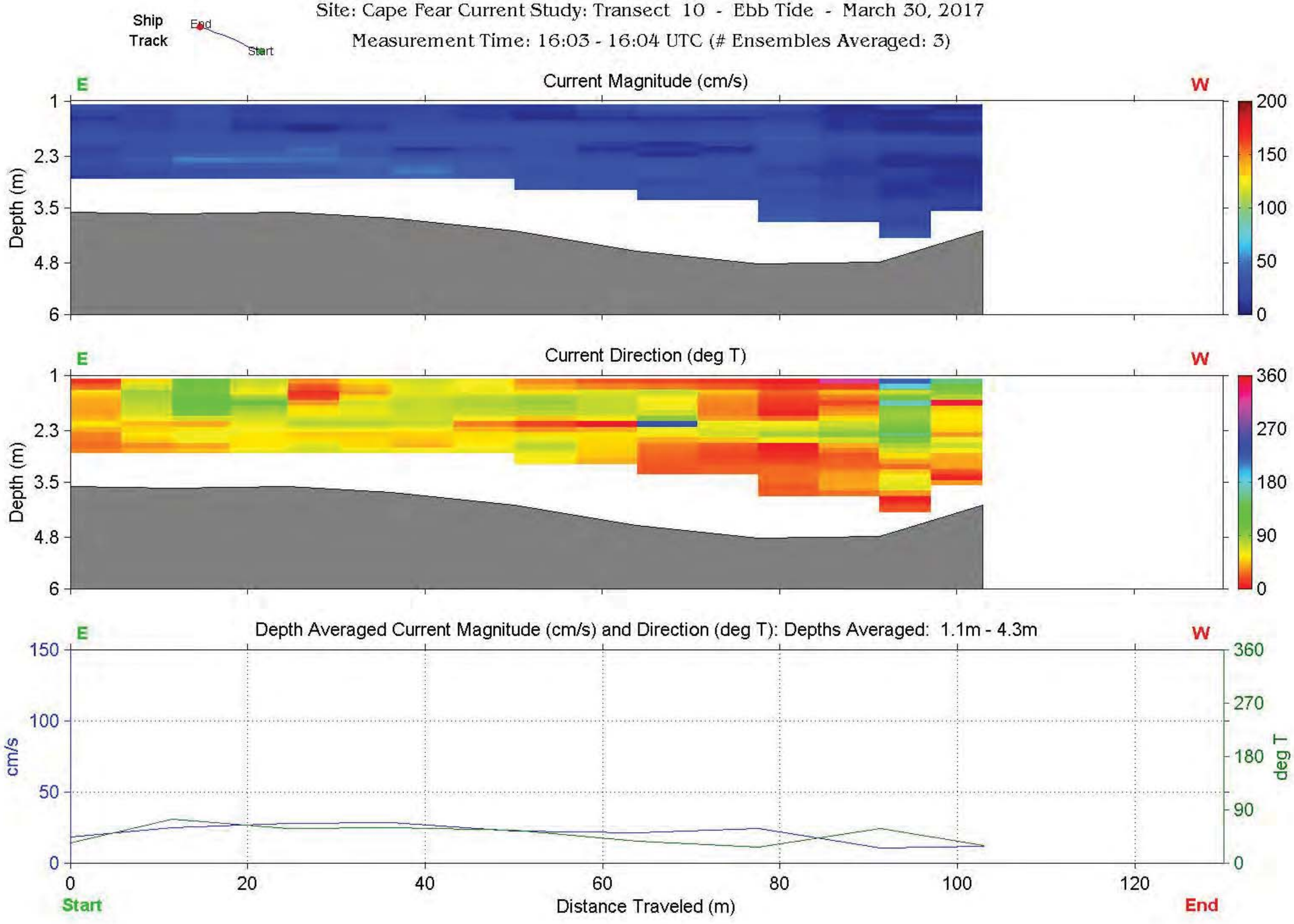
Site: Cape Fear Current Study: Transect 10 - Slack Tide - March 30, 2017

Measurement Time: 14:49 - 14:50 UTC (# Ensembles Averaged: 3)



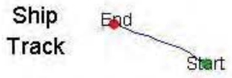
Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 30, 2017

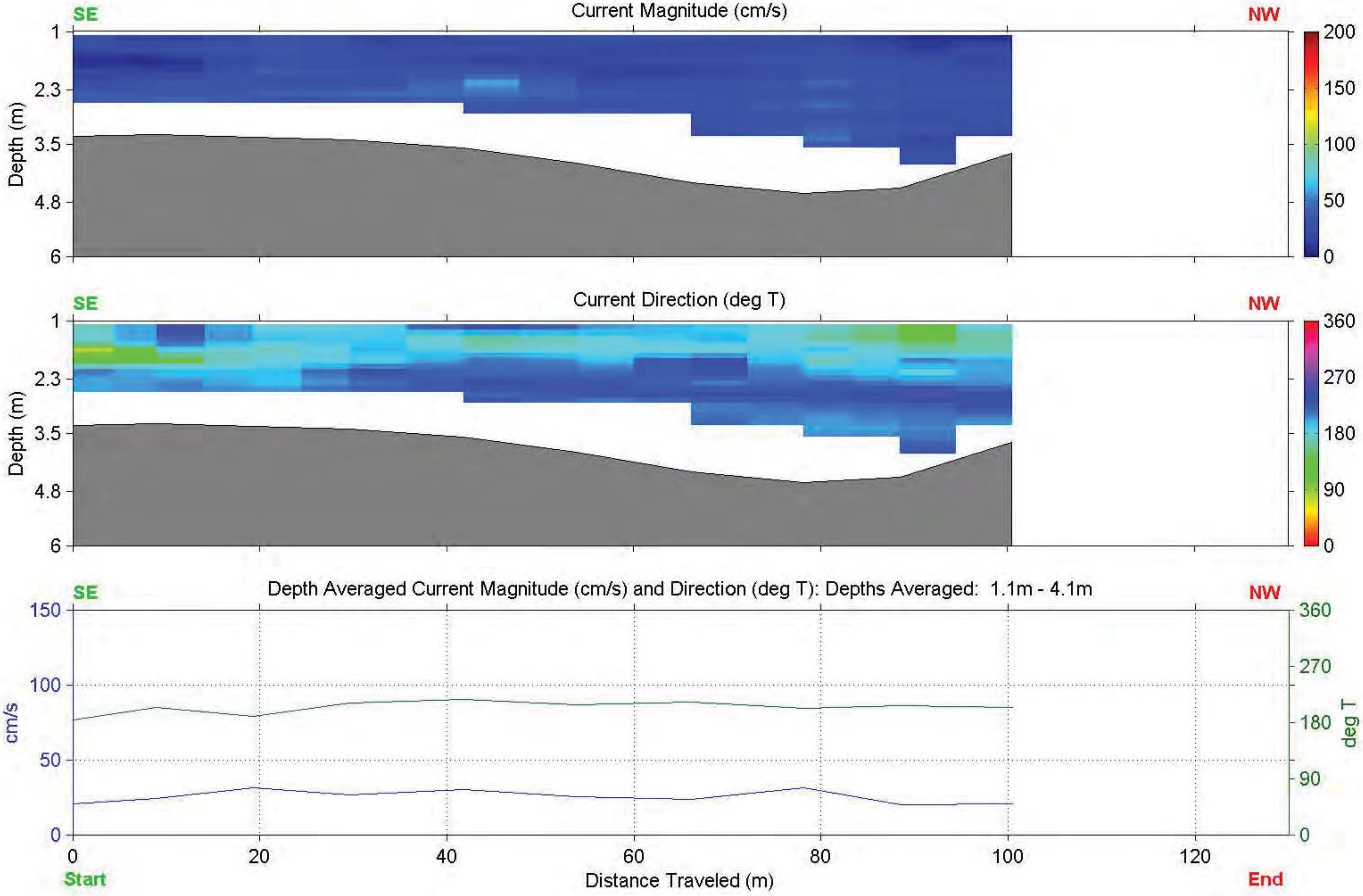
Measurement Time: 16:03 - 16:04 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 30, 2017

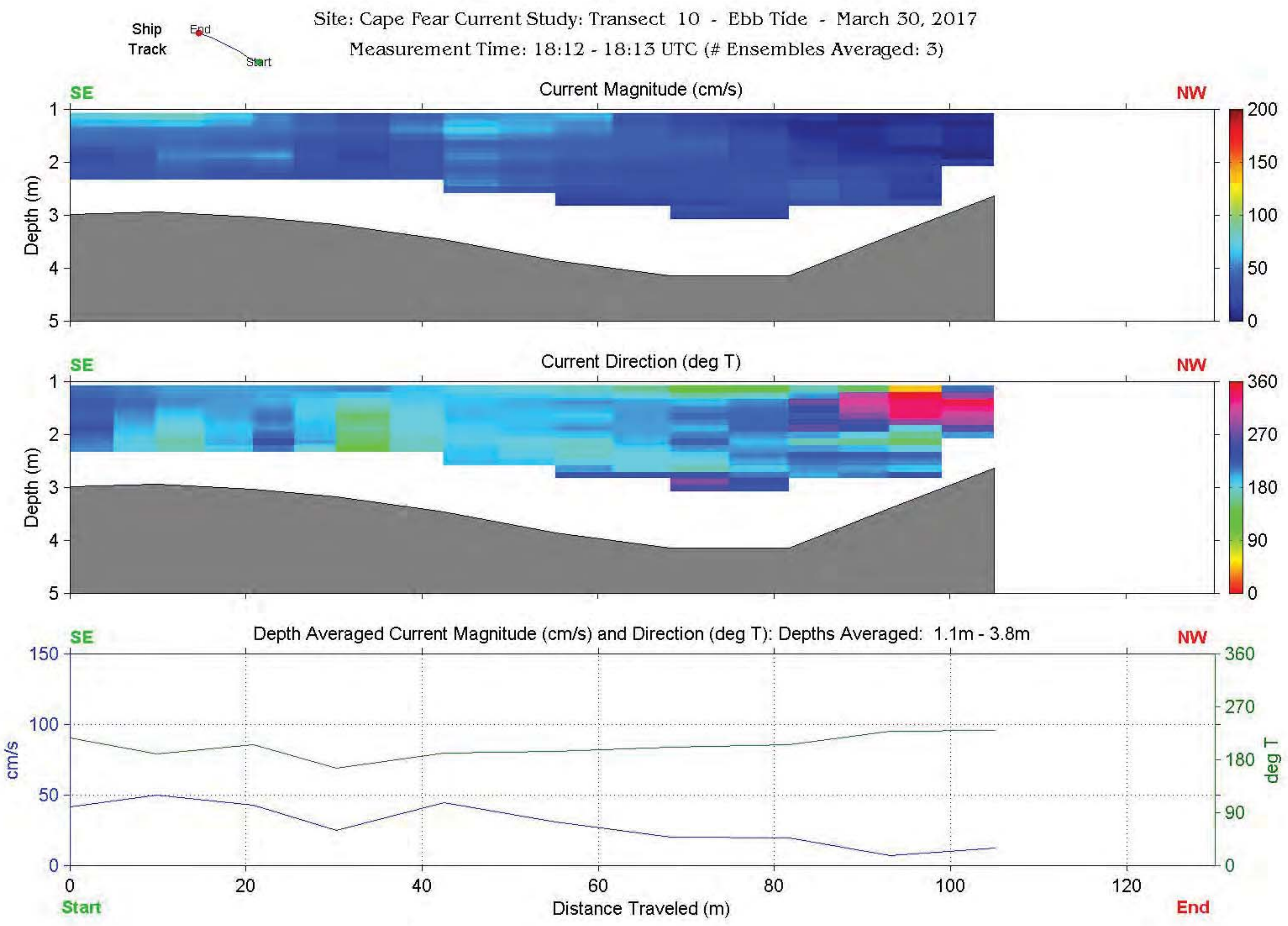
Measurement Time: 17:07 - 17:08 UTC (# Ensembles Averaged: 3)




Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.1m - 4.1m

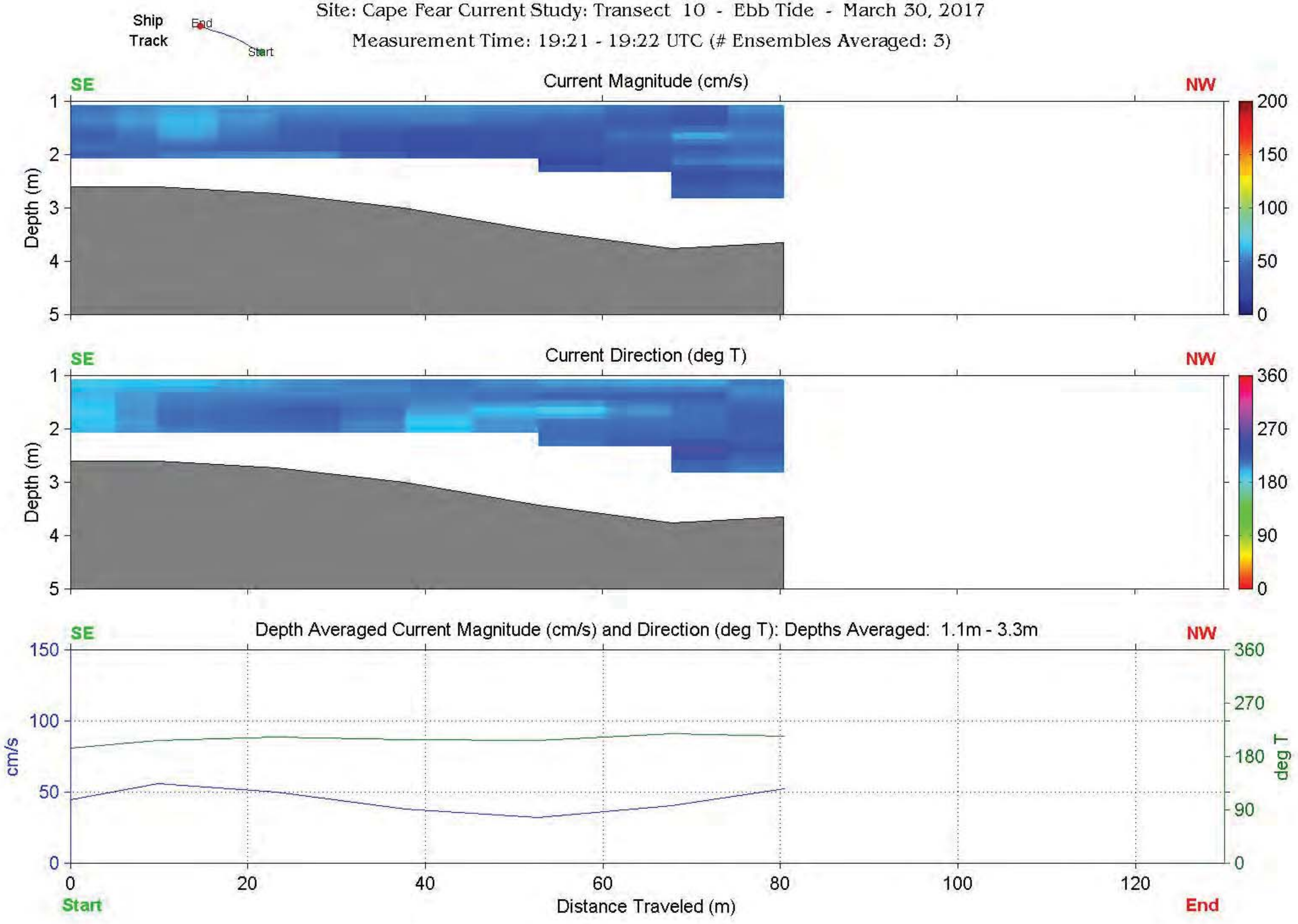


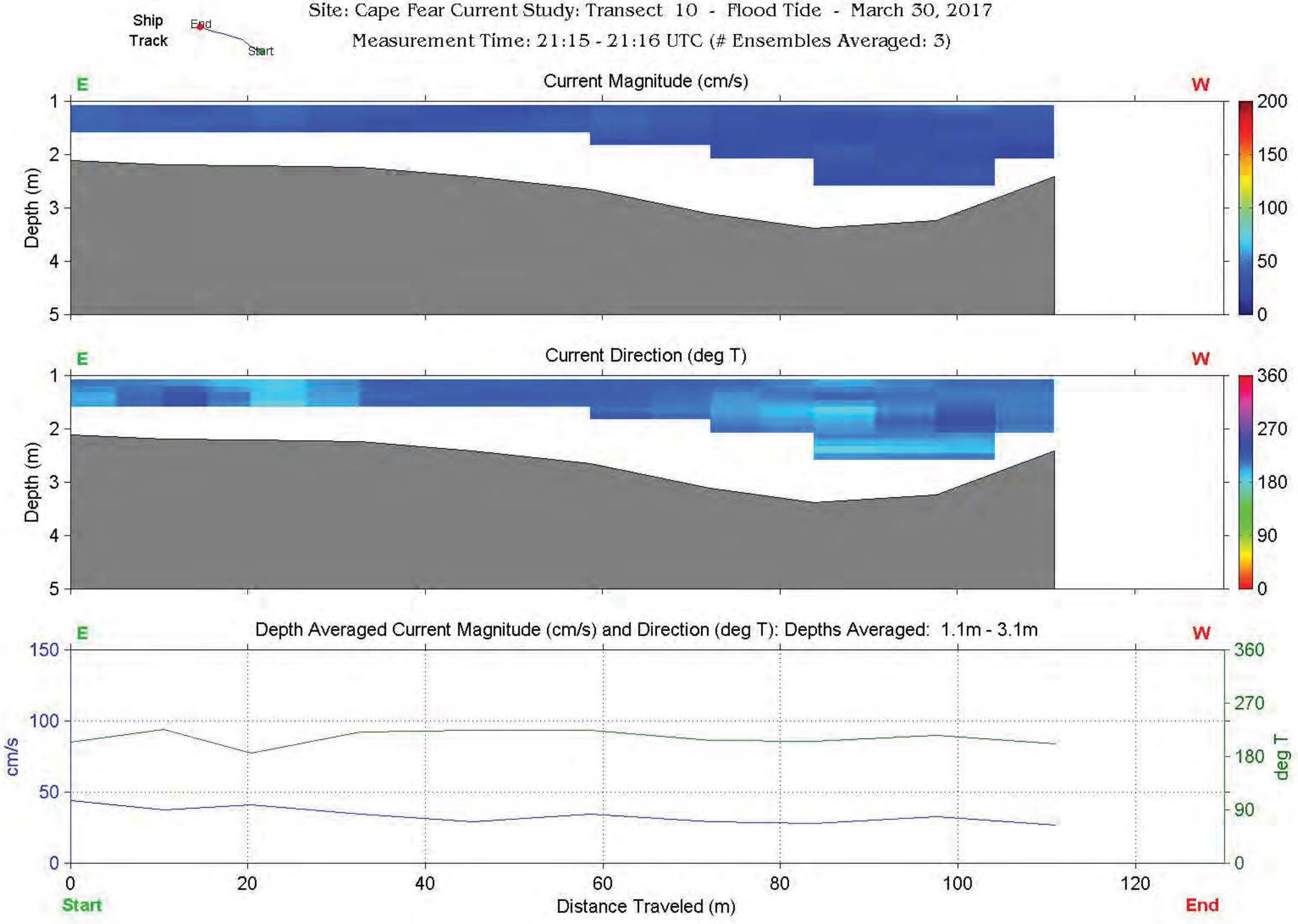
Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 30, 2017

Measurement Time: 18:12 - 18:13 UTC (# Ensembles Averaged: 3)

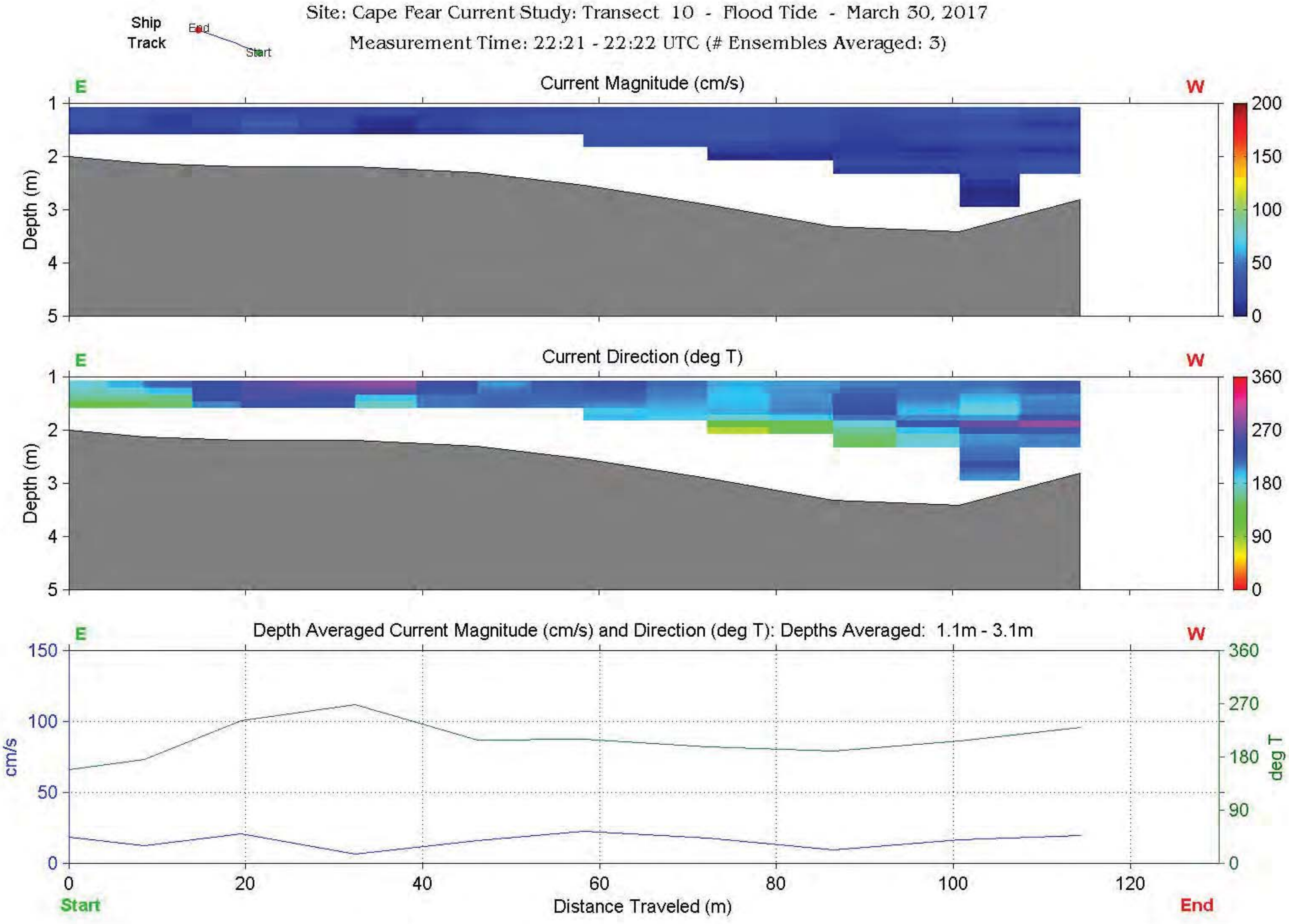
Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 30, 2017

Measurement Time: 19:21 - 19:22 UTC (# Ensembles Averaged: 3)



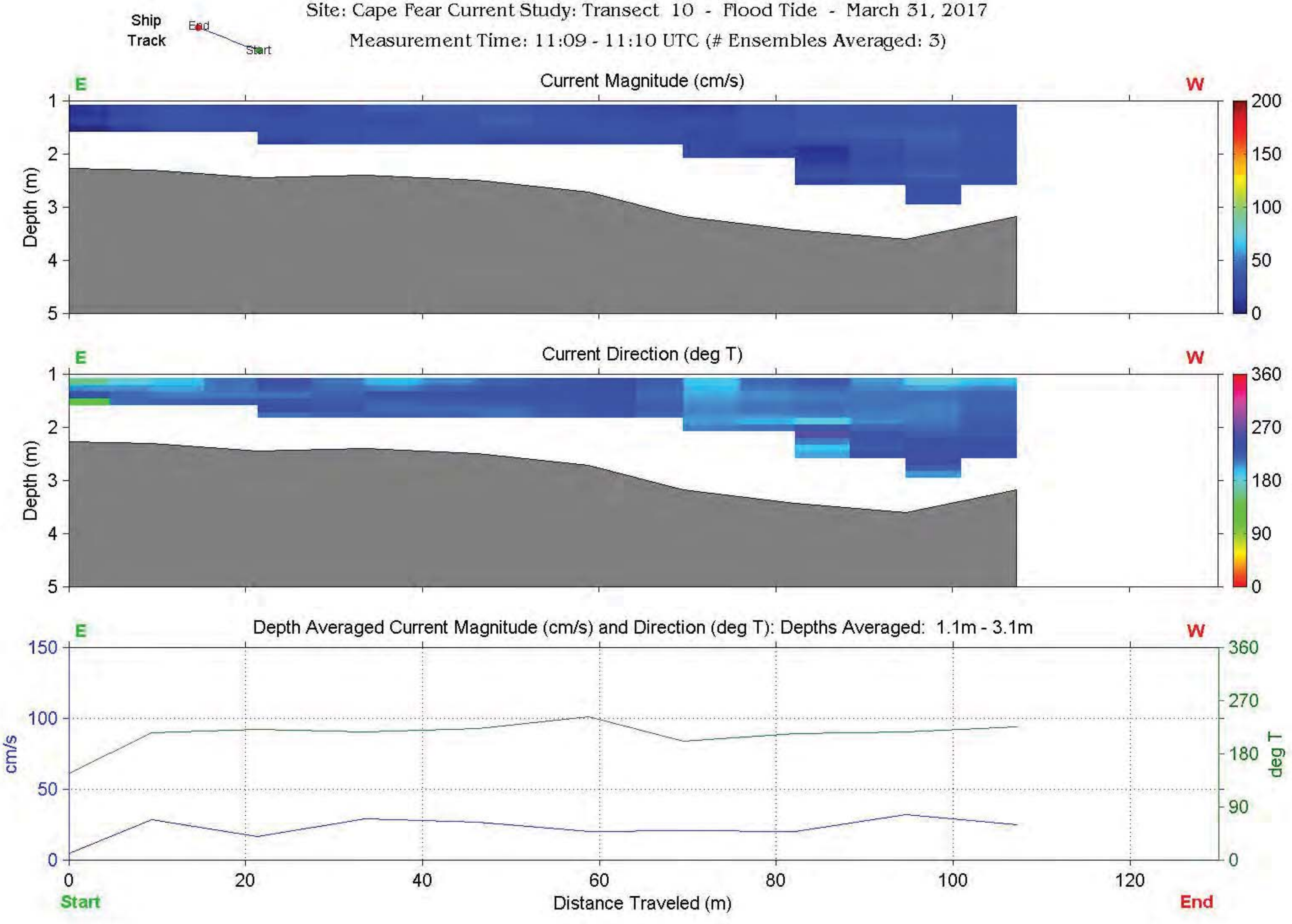

Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 30, 2017

Measurement Time: 21:15 - 21:16 UTC (# Ensembles Averaged: 3)



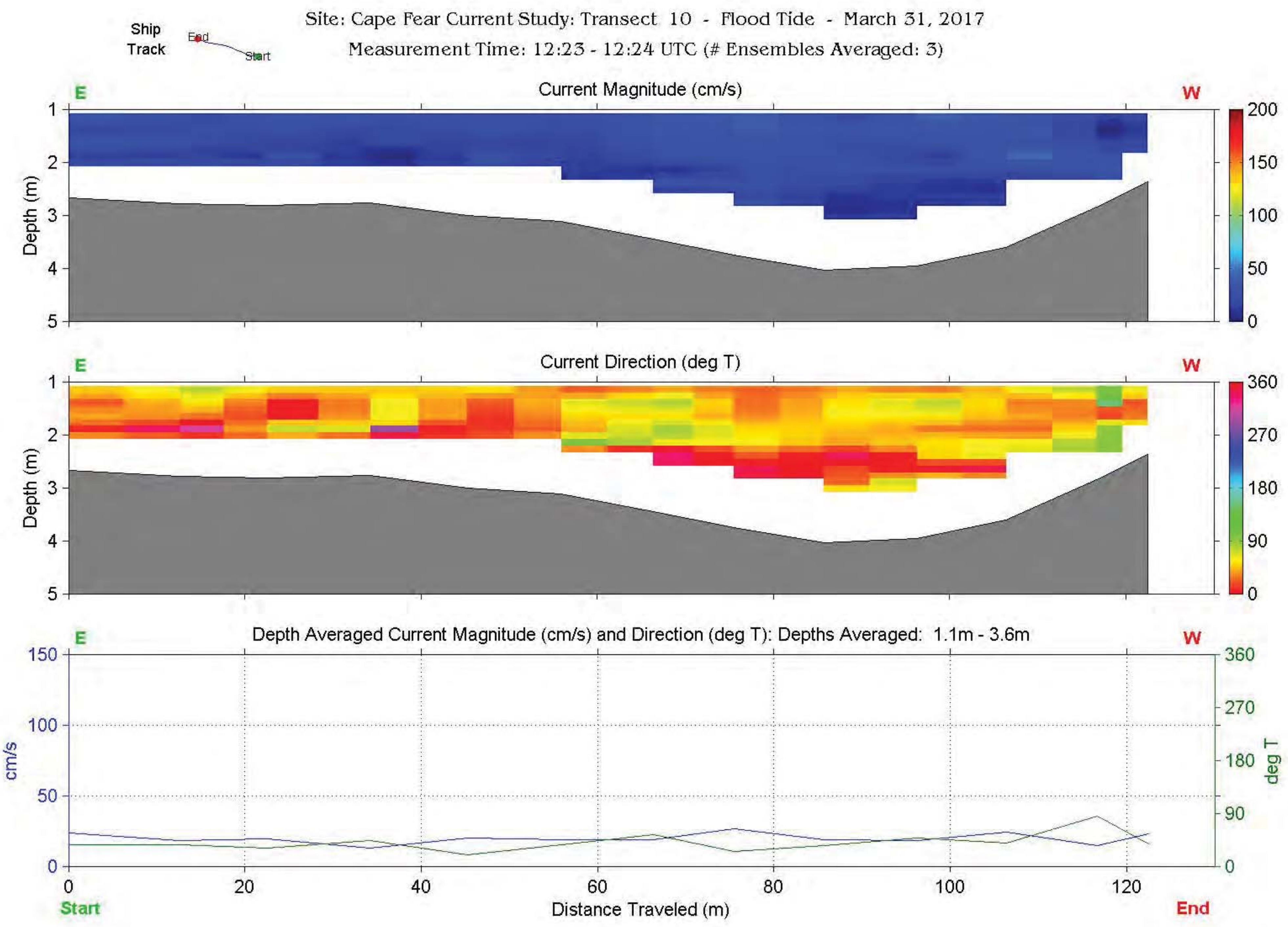
Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 30, 2017

Measurement Time: 22:21 - 22:22 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 31, 2017

Measurement Time: 11:09 - 11:10 UTC (# Ensembles Averaged: 3)

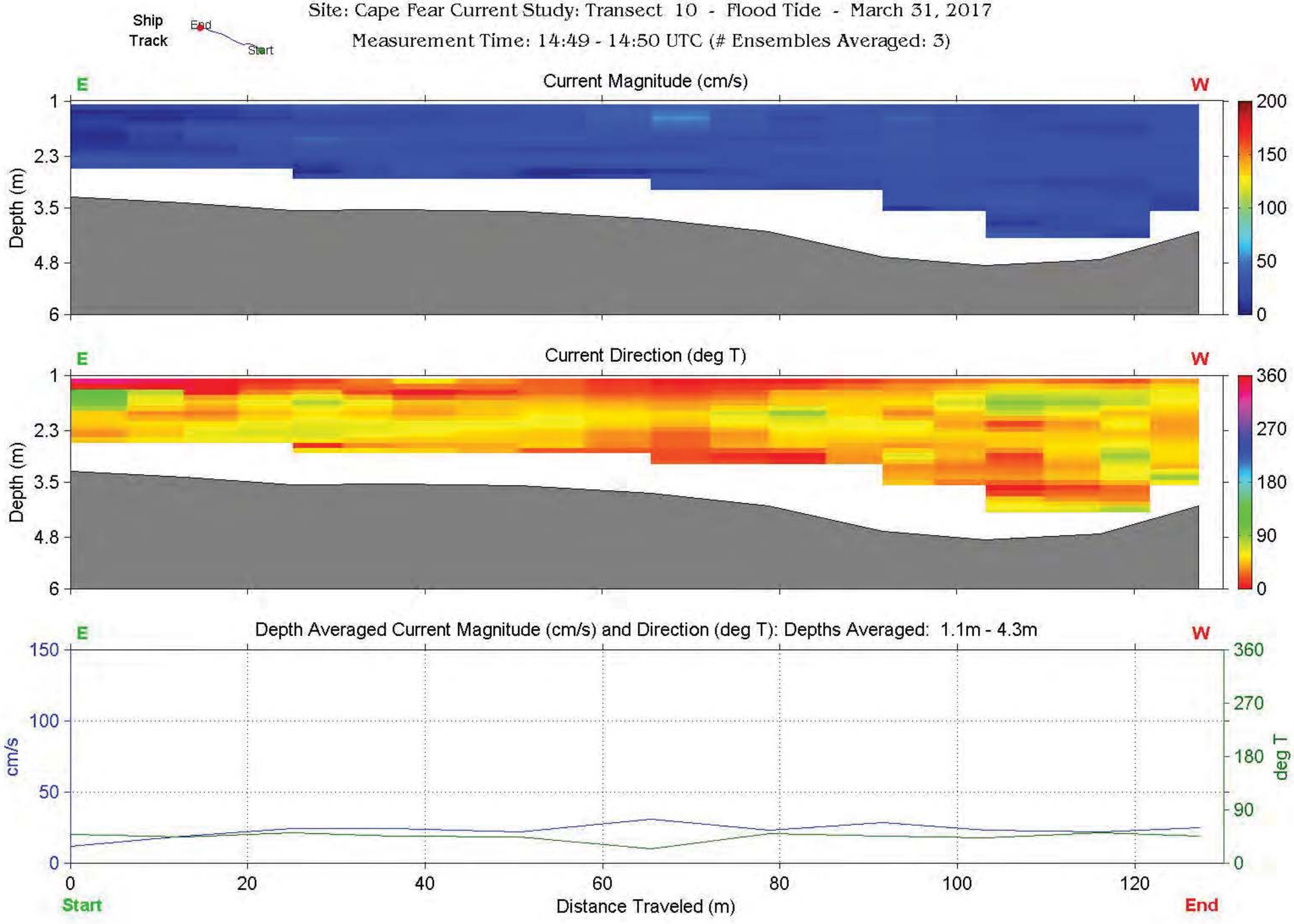


Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 31, 2017

Measurement Time: 12:23 - 12:24 UTC (# Ensembles Averaged: 3)

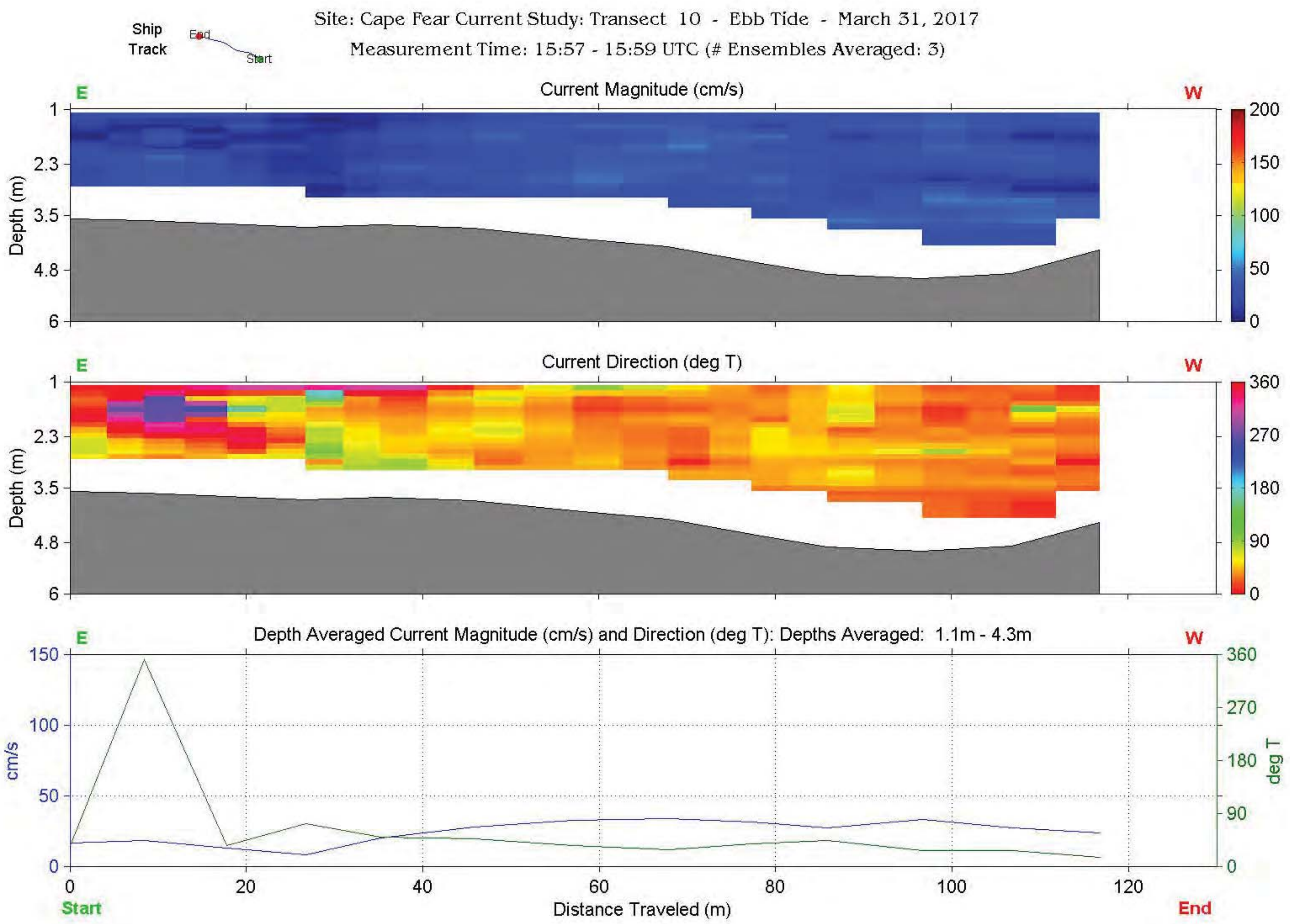
Site: Cape Fear Current Study: Transect 10 - Flood Tide - March 31, 2017

Measurement Time: 14:49 - 14:50 UTC (# Ensembles Averaged: 3)



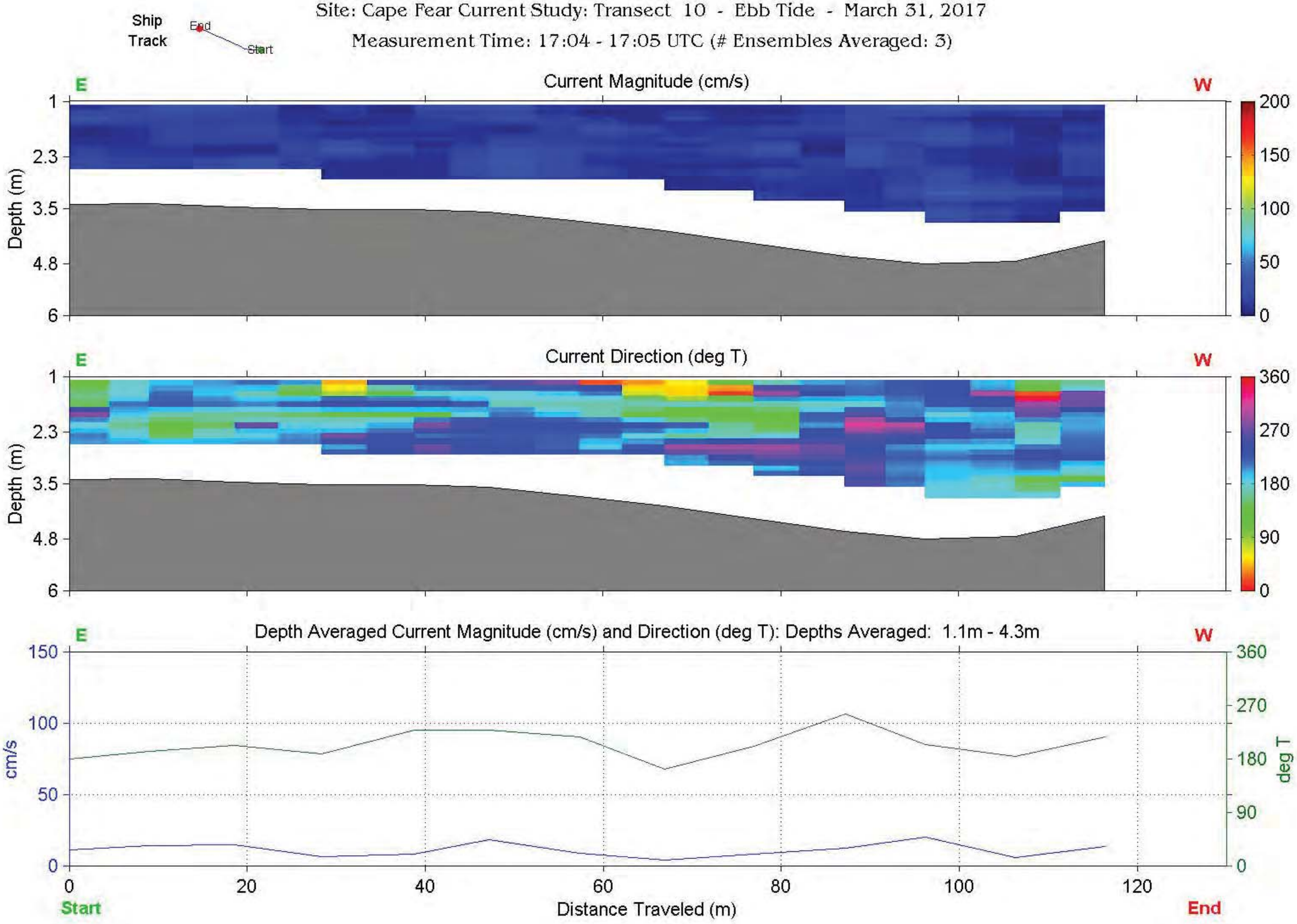
Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 31, 2017

Measurement Time: 15:57 - 15:59 UTC (# Ensembles Averaged: 3)

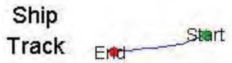


Site: Cape Fear Current Study: Transect 10 - Ebb Tide - March 31, 2017

Measurement Time: 17:04 - 17:05 UTC (# Ensembles Averaged: 3)

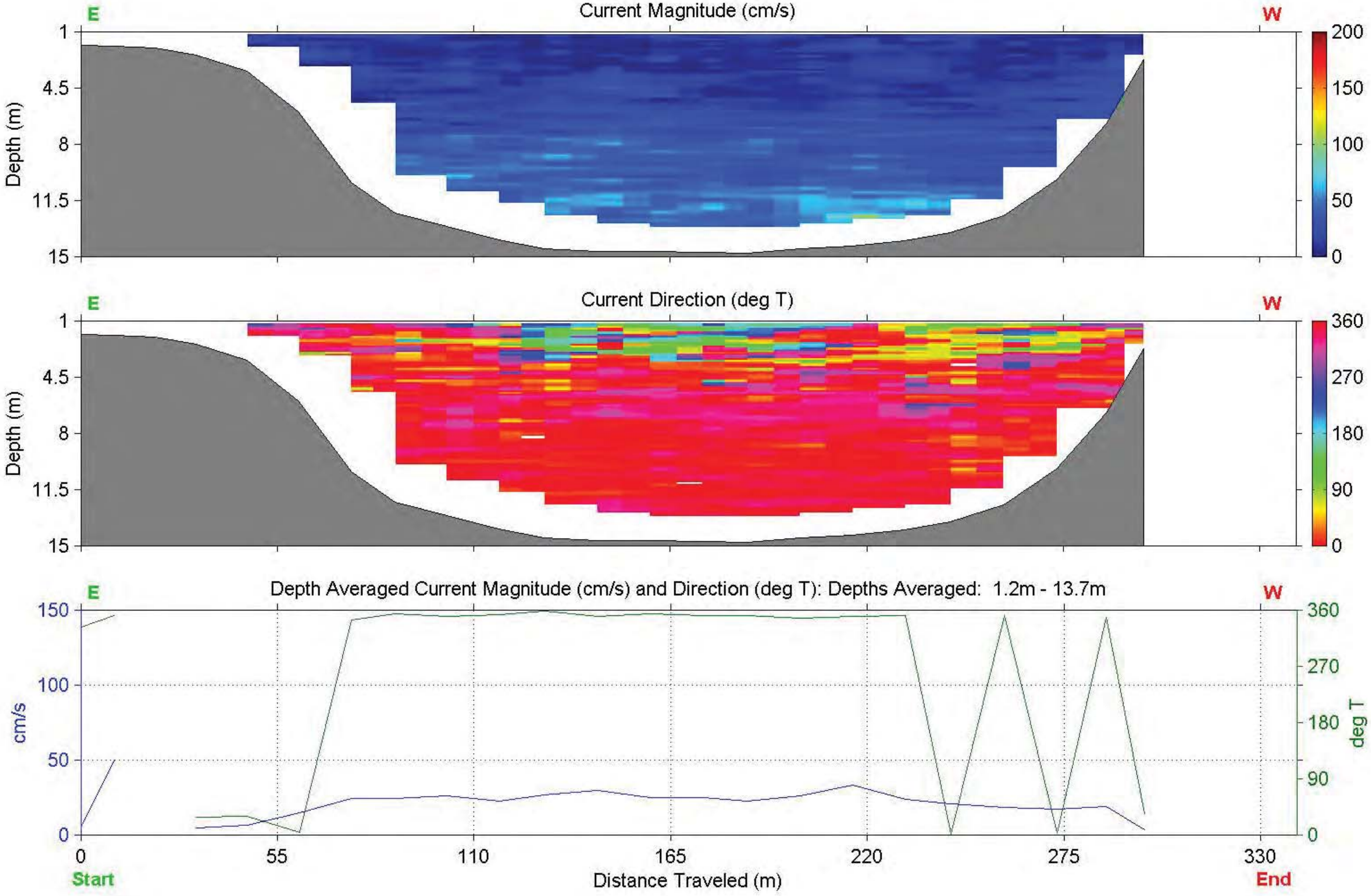


Wilmington
South of Port



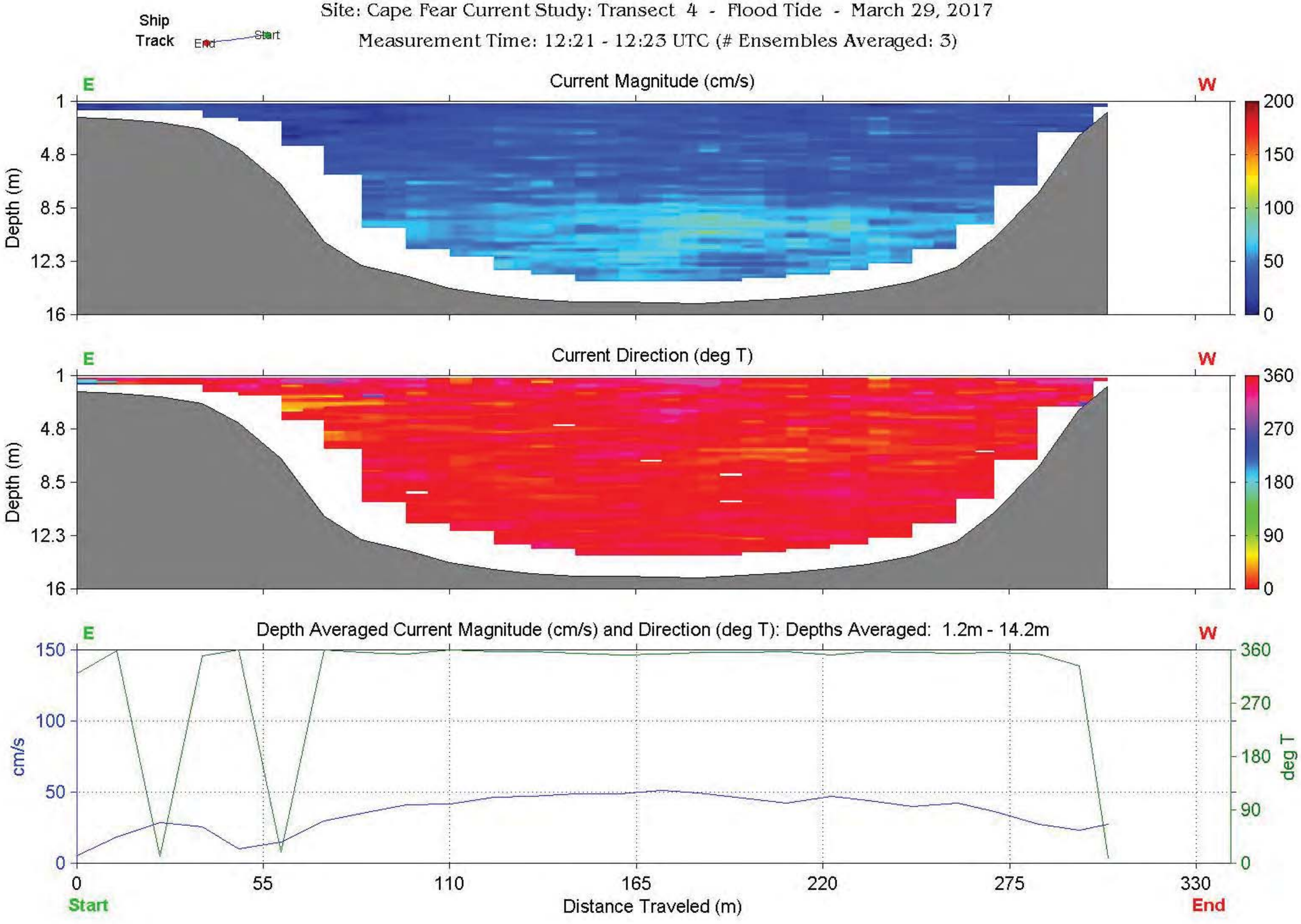
Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 29, 2017

Measurement Time: 11:37 - 11:39 UTC (# Ensembles Averaged: 3)



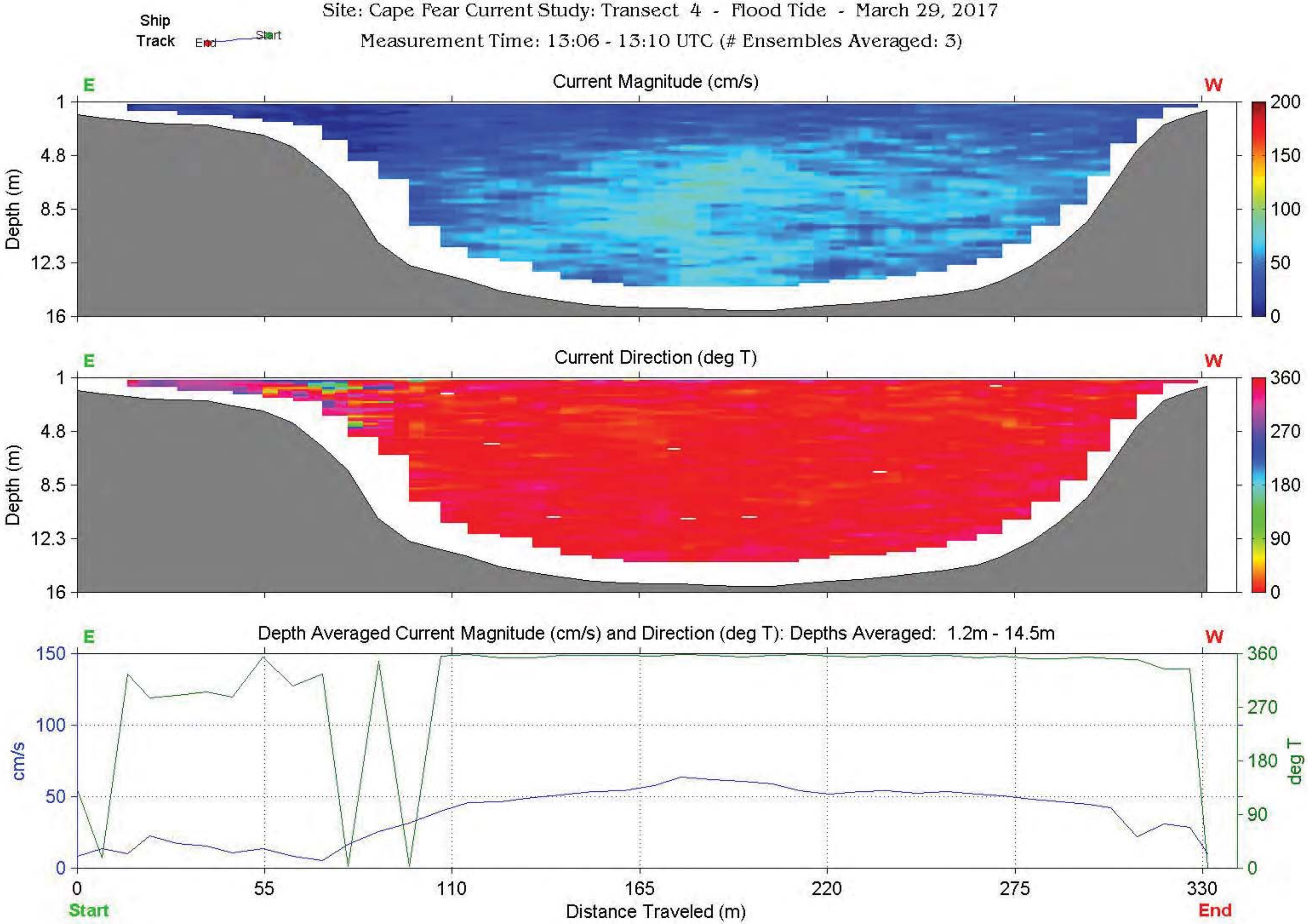
Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 29, 2017

Measurement Time: 12:21 - 12:23 UTC (# Ensembles Averaged: 3)



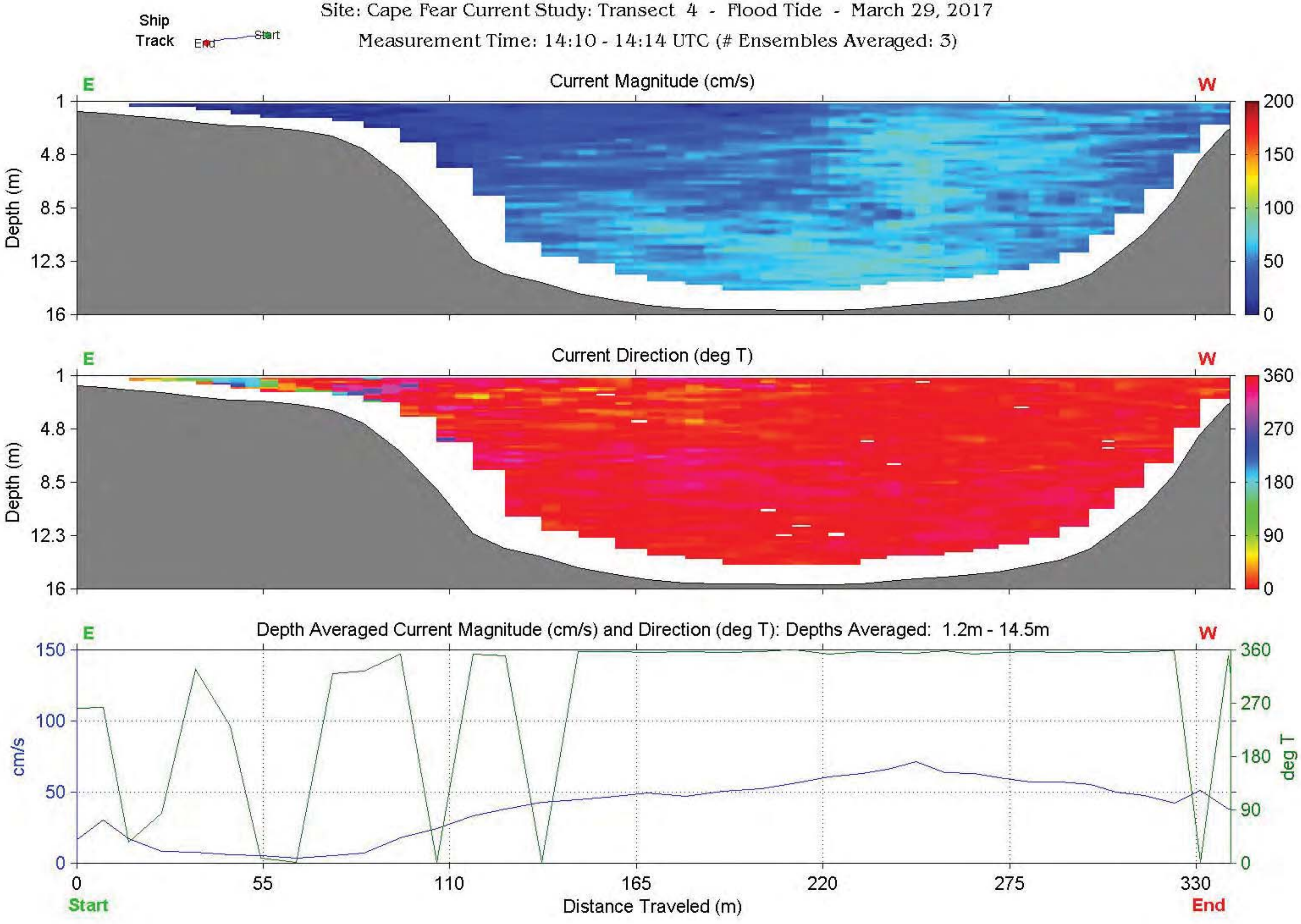
Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 29, 2017

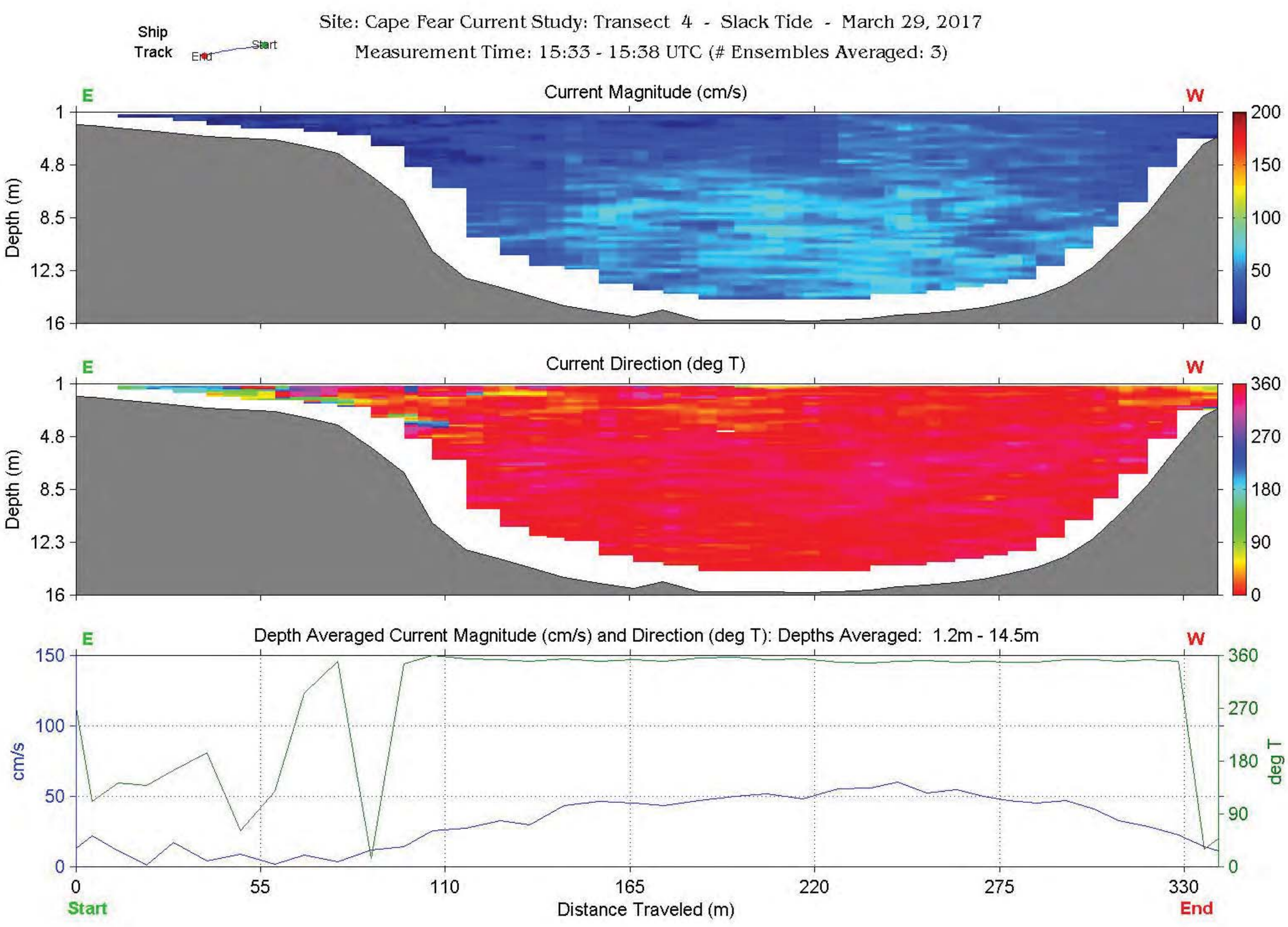
Measurement Time: 13:06 - 13:10 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 29, 2017

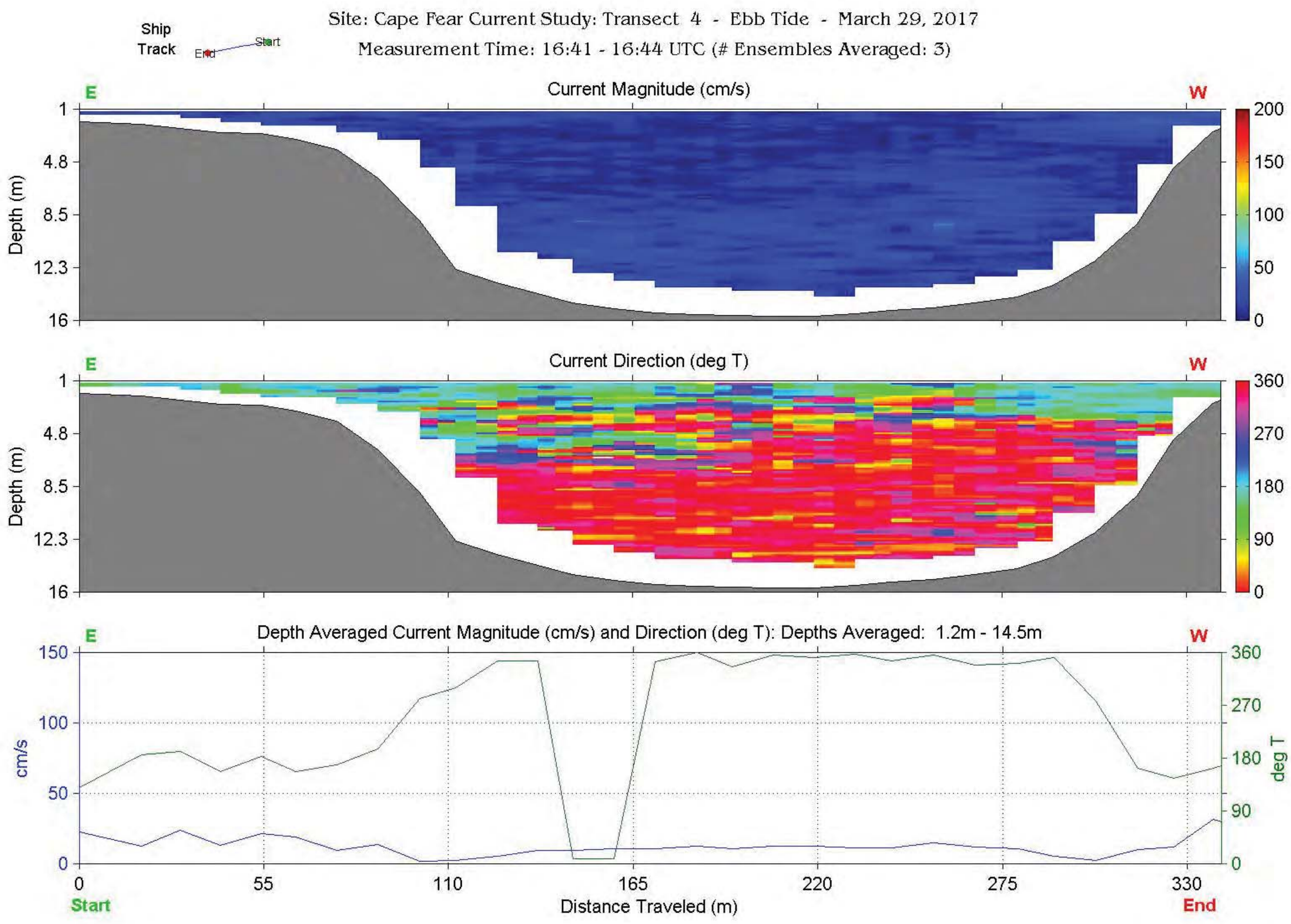
Measurement Time: 14:10 - 14:14 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 4 - Slack Tide - March 29, 2017

Measurement Time: 15:33 - 15:38 UTC (# Ensembles Averaged: 3)

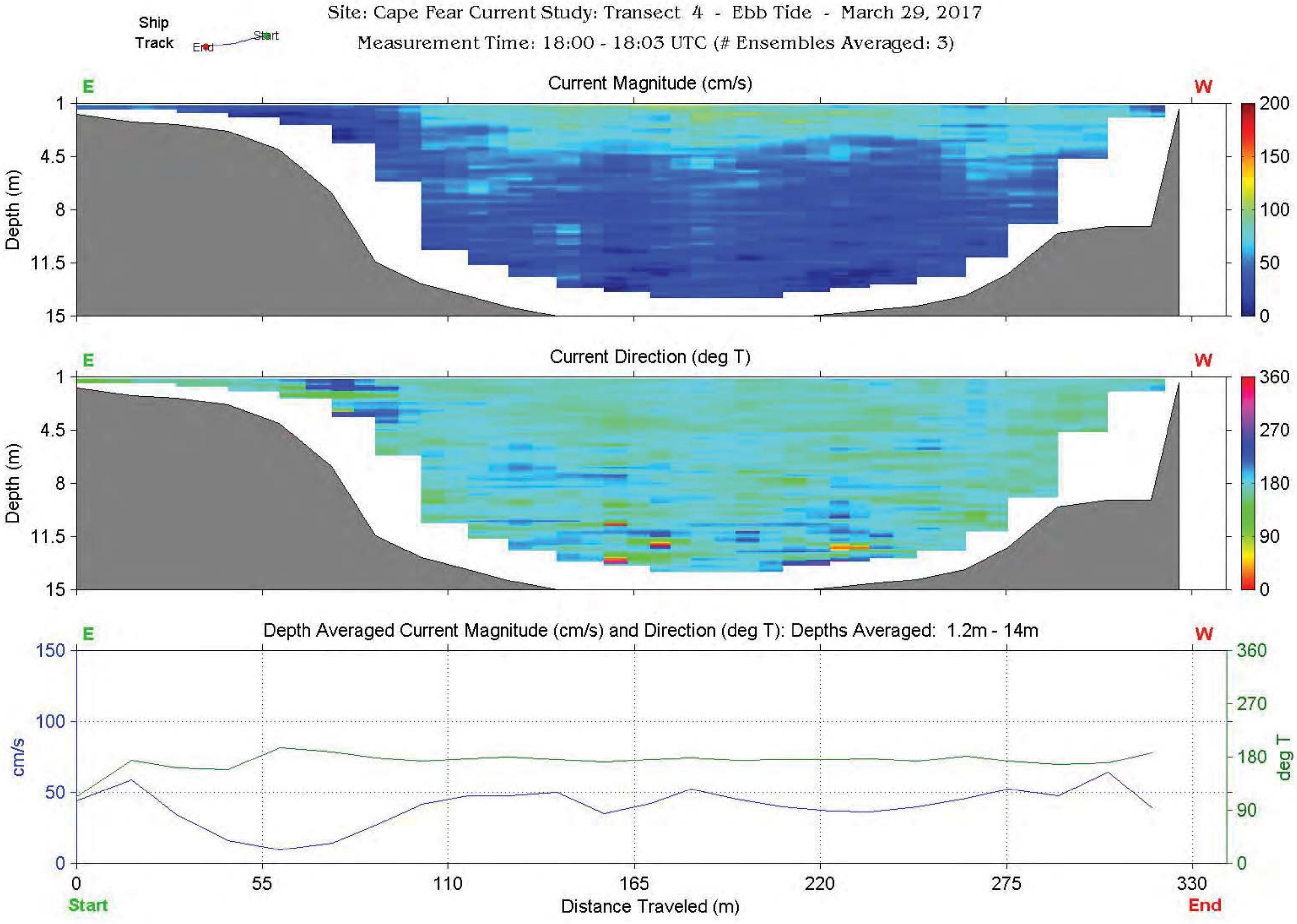


Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 29, 2017

Measurement Time: 16:41 - 16:44 UTC (# Ensembles Averaged: 3)

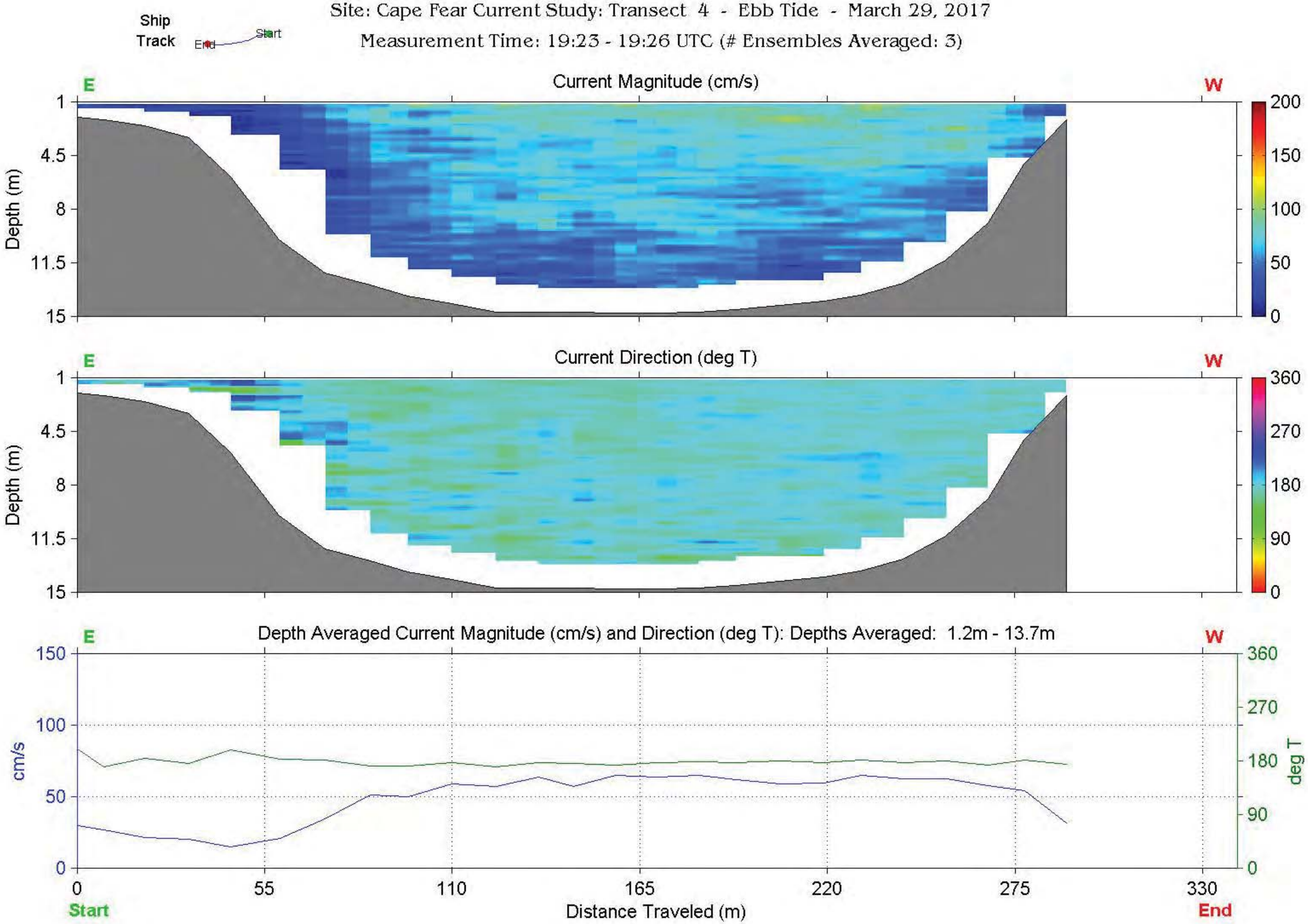
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 29, 2017

Measurement Time: 18:00 - 18:03 UTC (# Ensembles Averaged: 3)



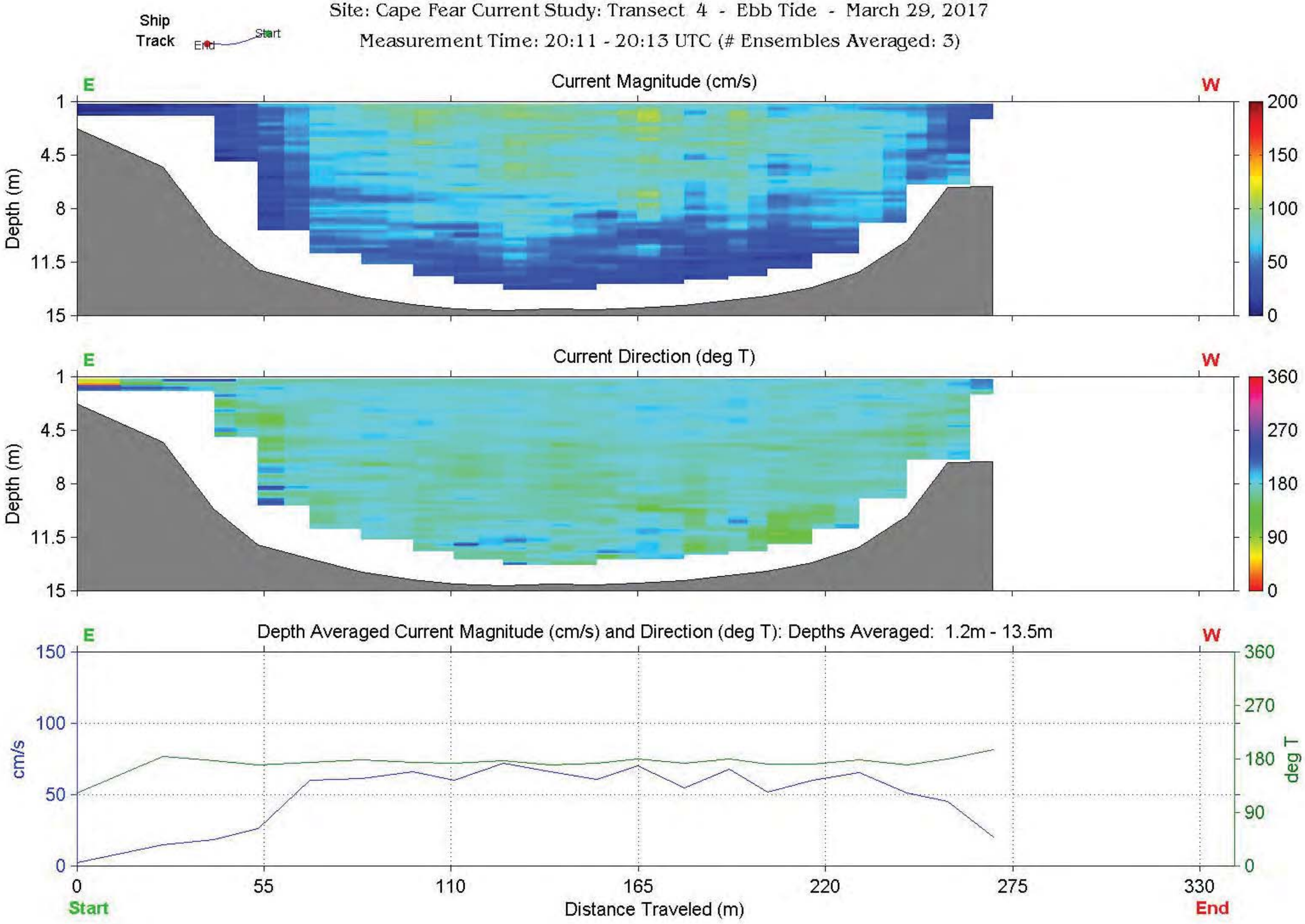
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 29, 2017

Measurement Time: 19:23 - 19:26 UTC (# Ensembles Averaged: 3)



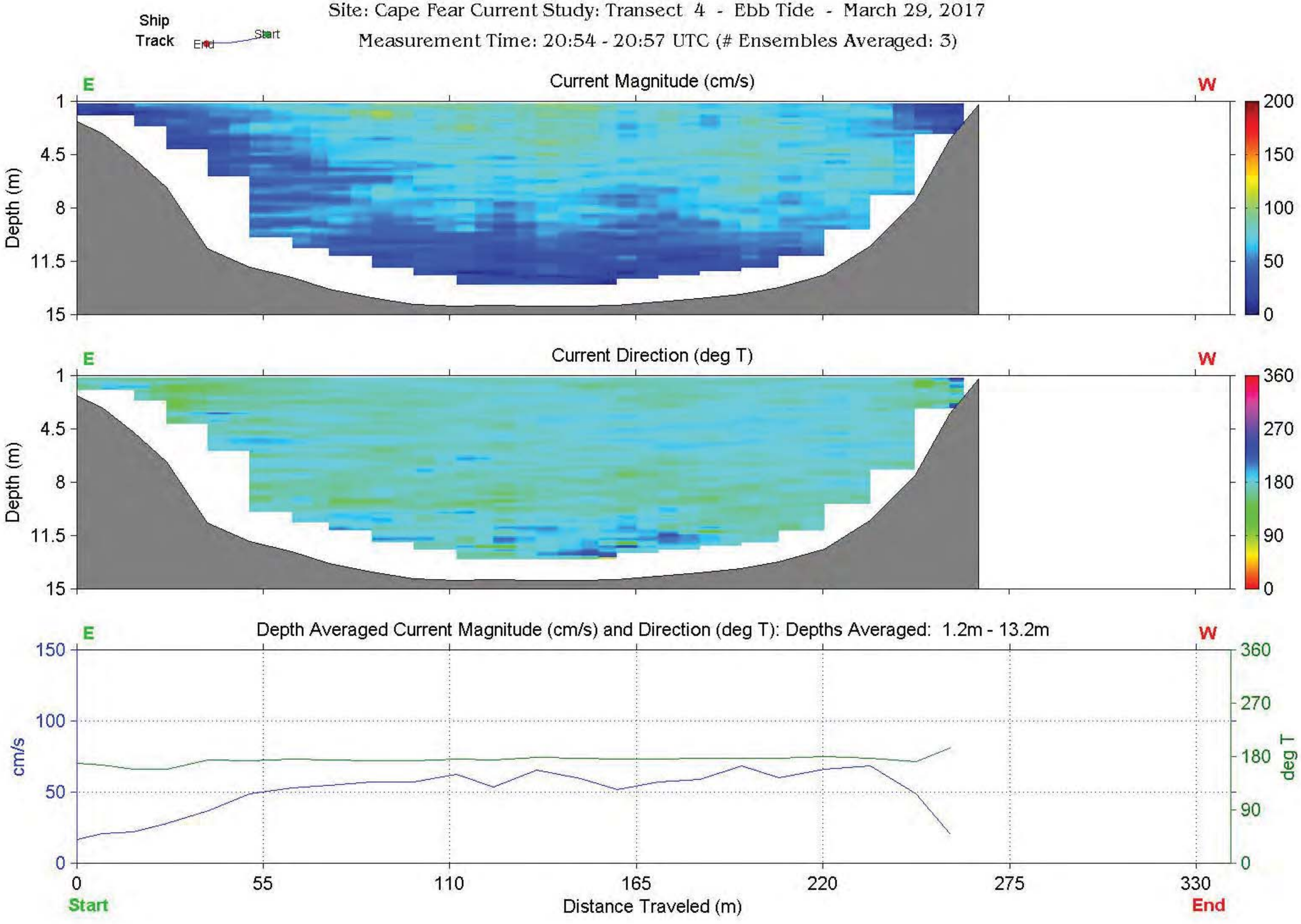
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 29, 2017

Measurement Time: 20:11 - 20:13 UTC (# Ensembles Averaged: 3)



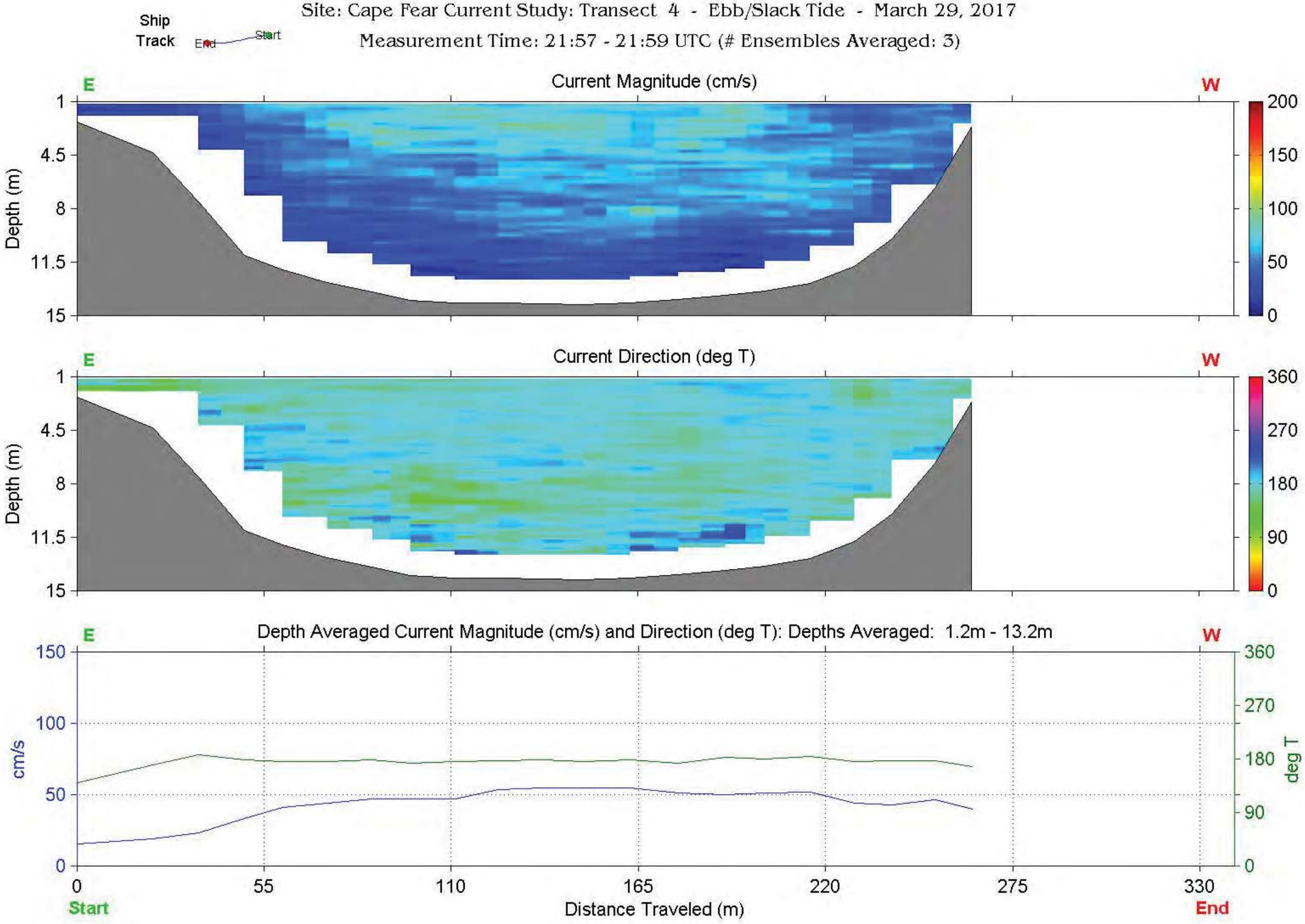
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 29, 2017

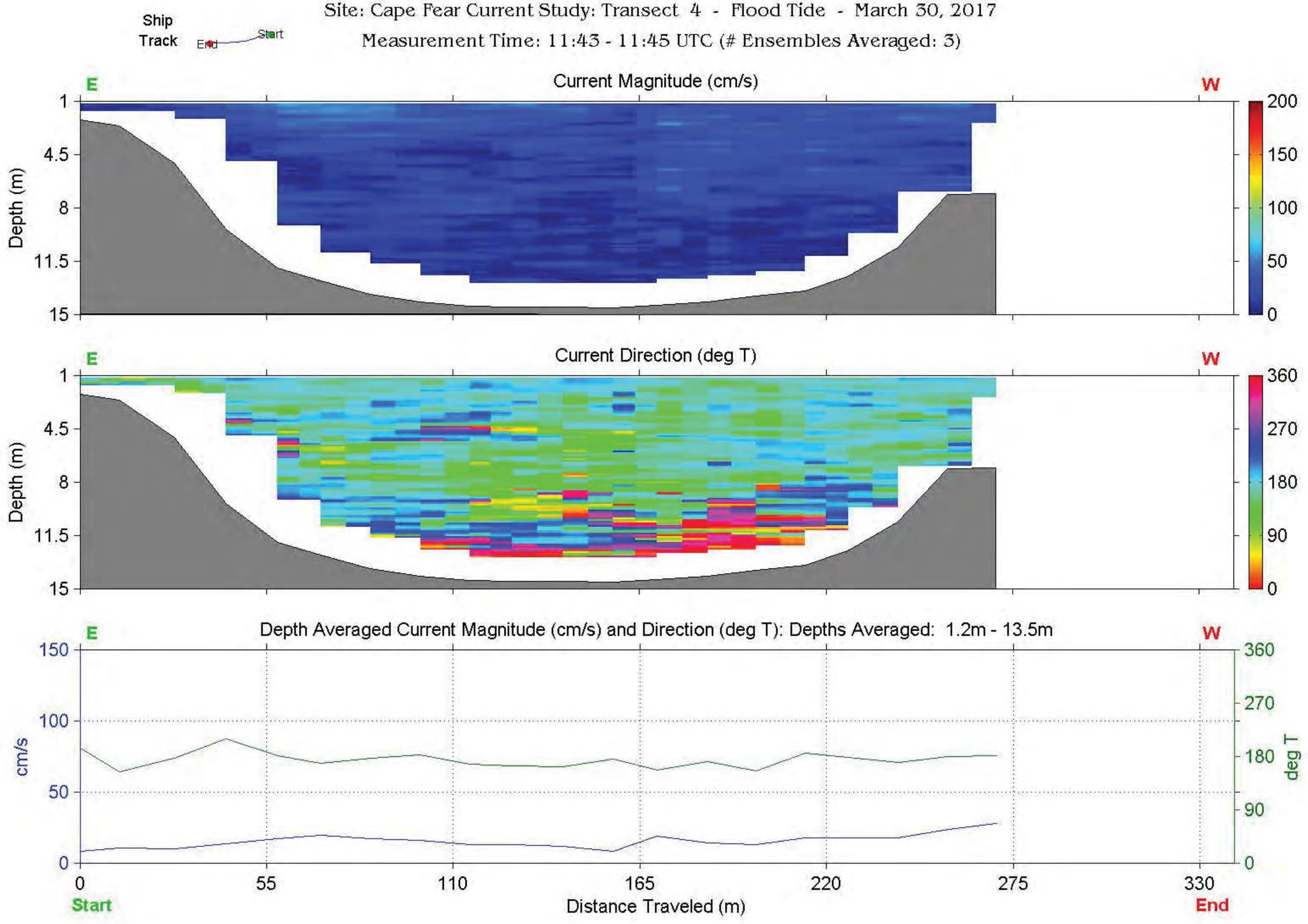
Measurement Time: 20:54 - 20:57 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 4 - Ebb/Slack Tide - March 29, 2017

Measurement Time: 21:57 - 21:59 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 30, 2017

Measurement Time: 11:43 - 11:45 UTC (# Ensembles Averaged: 3)

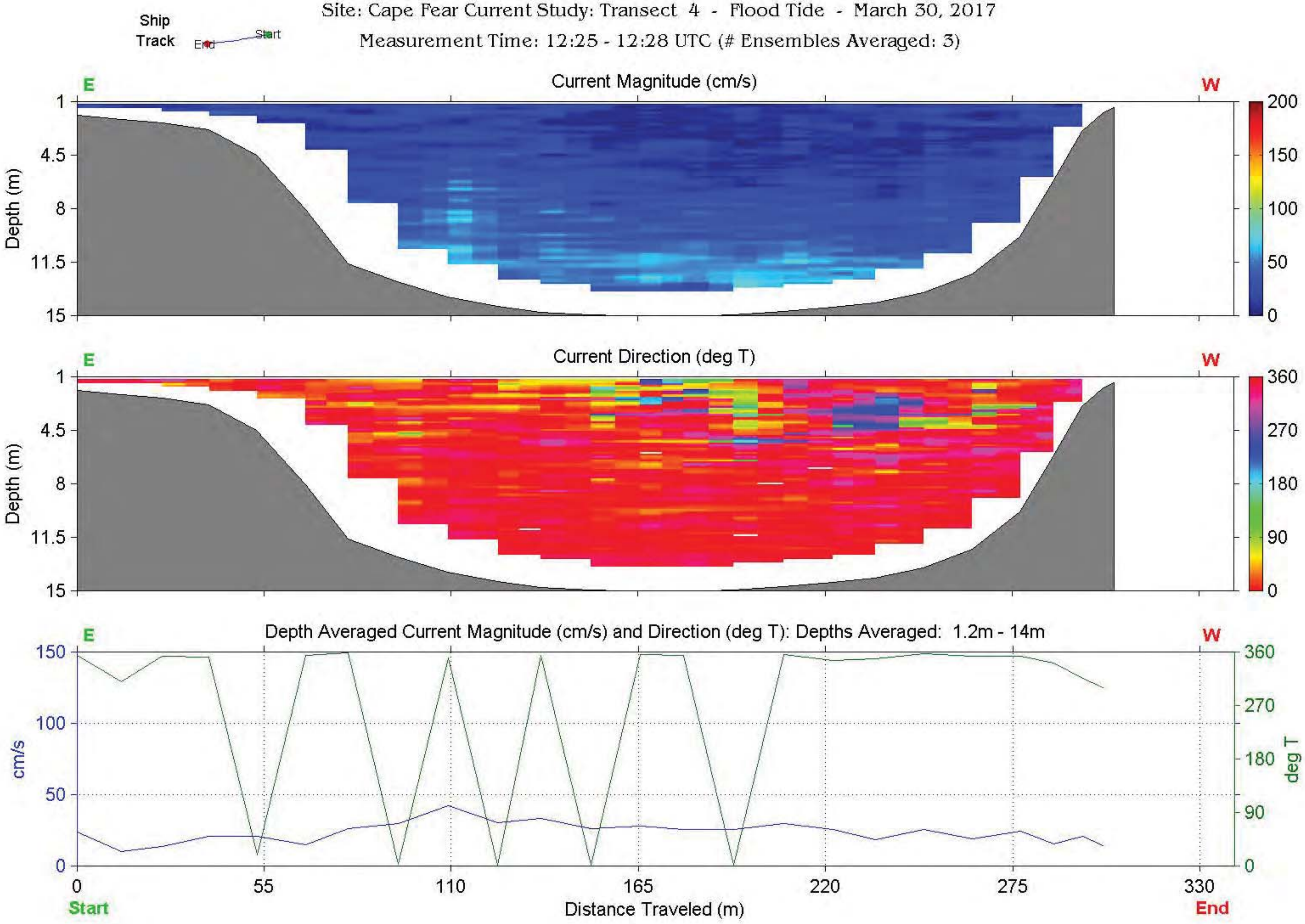
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 13.5m

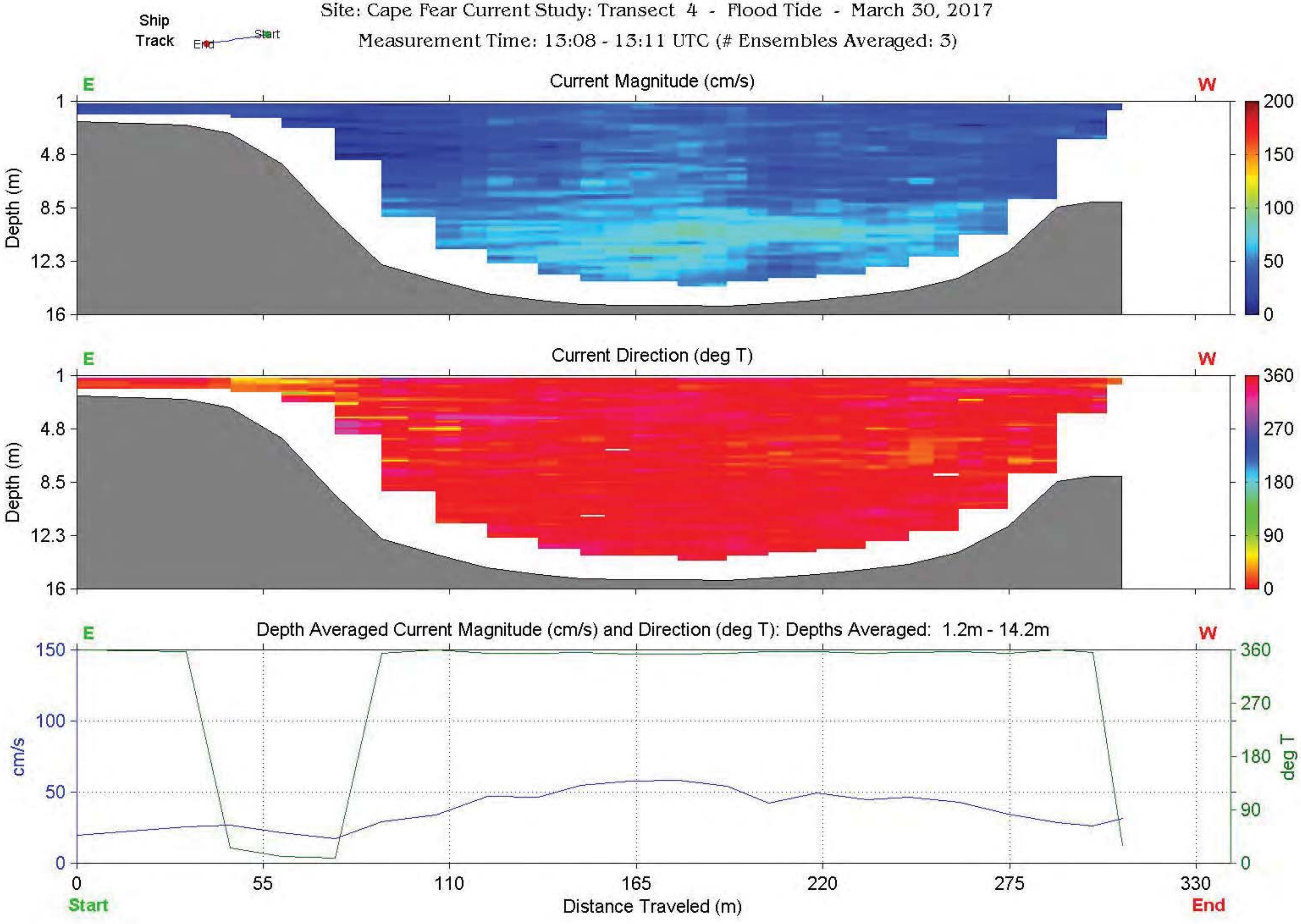
Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 30, 2017

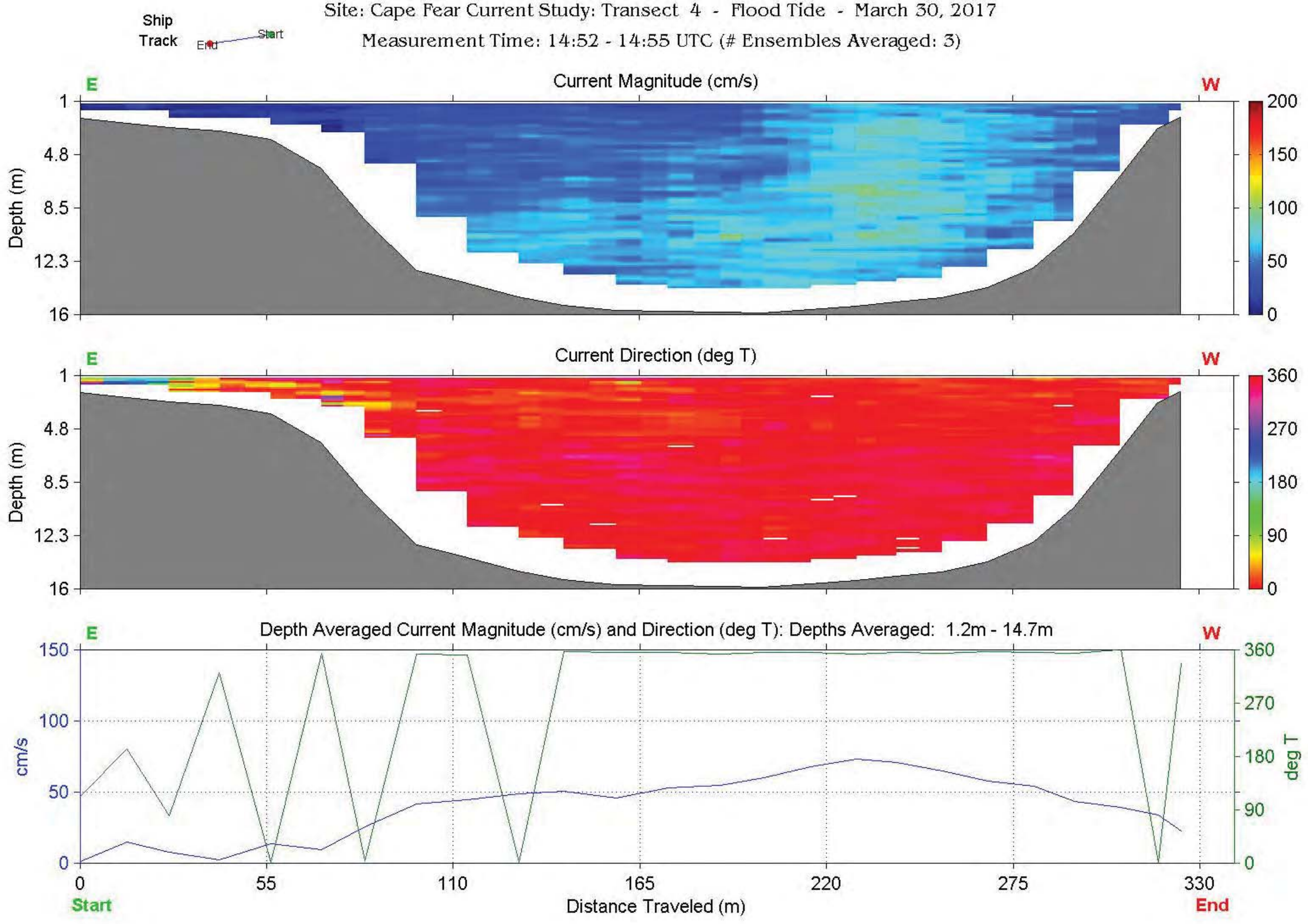
Measurement Time: 12:25 - 12:28 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 30, 2017

Measurement Time: 13:08 - 13:11 UTC (# Ensembles Averaged: 3)



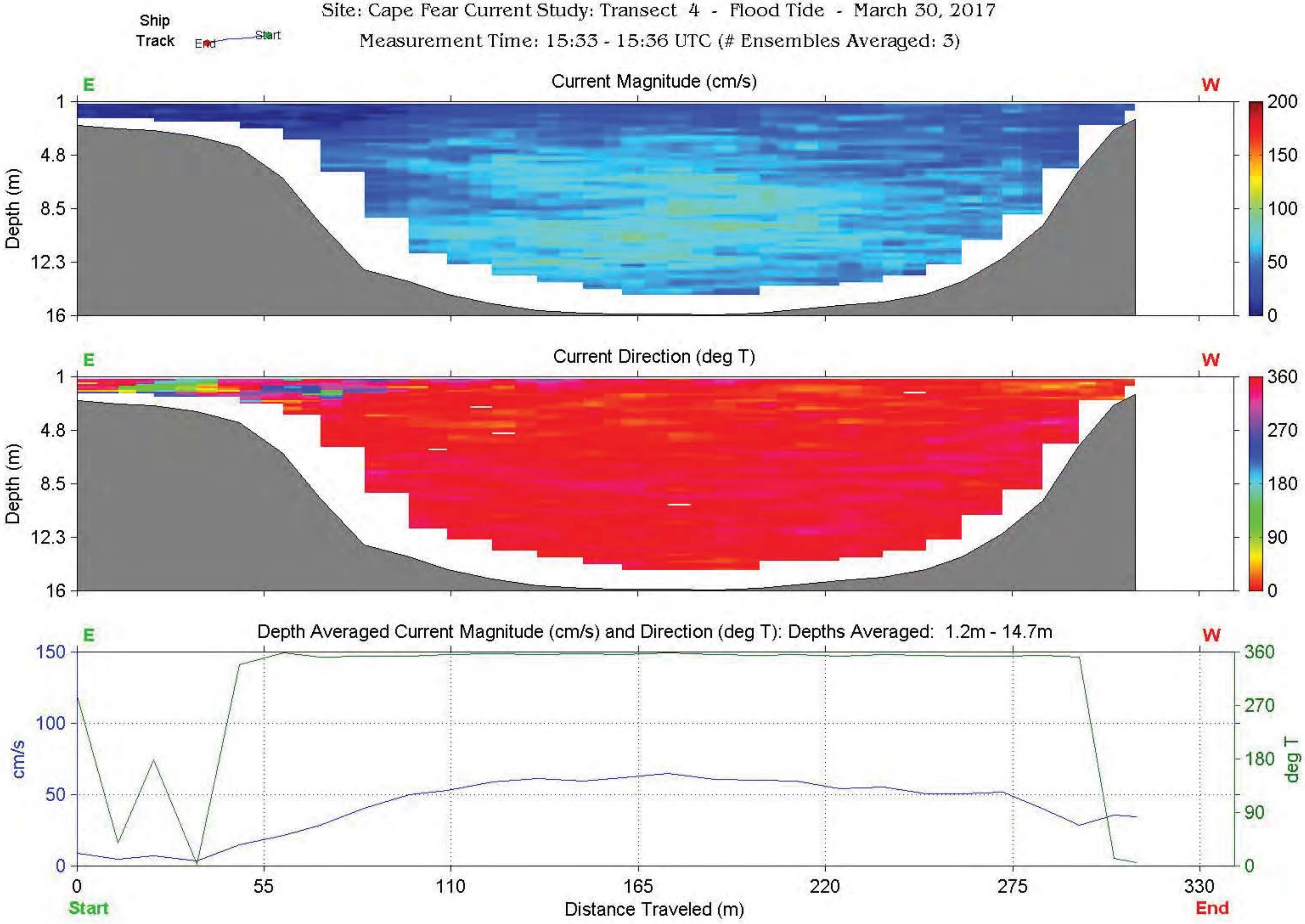


Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 30, 2017

Measurement Time: 14:52 - 14:55 UTC (# Ensembles Averaged: 3)

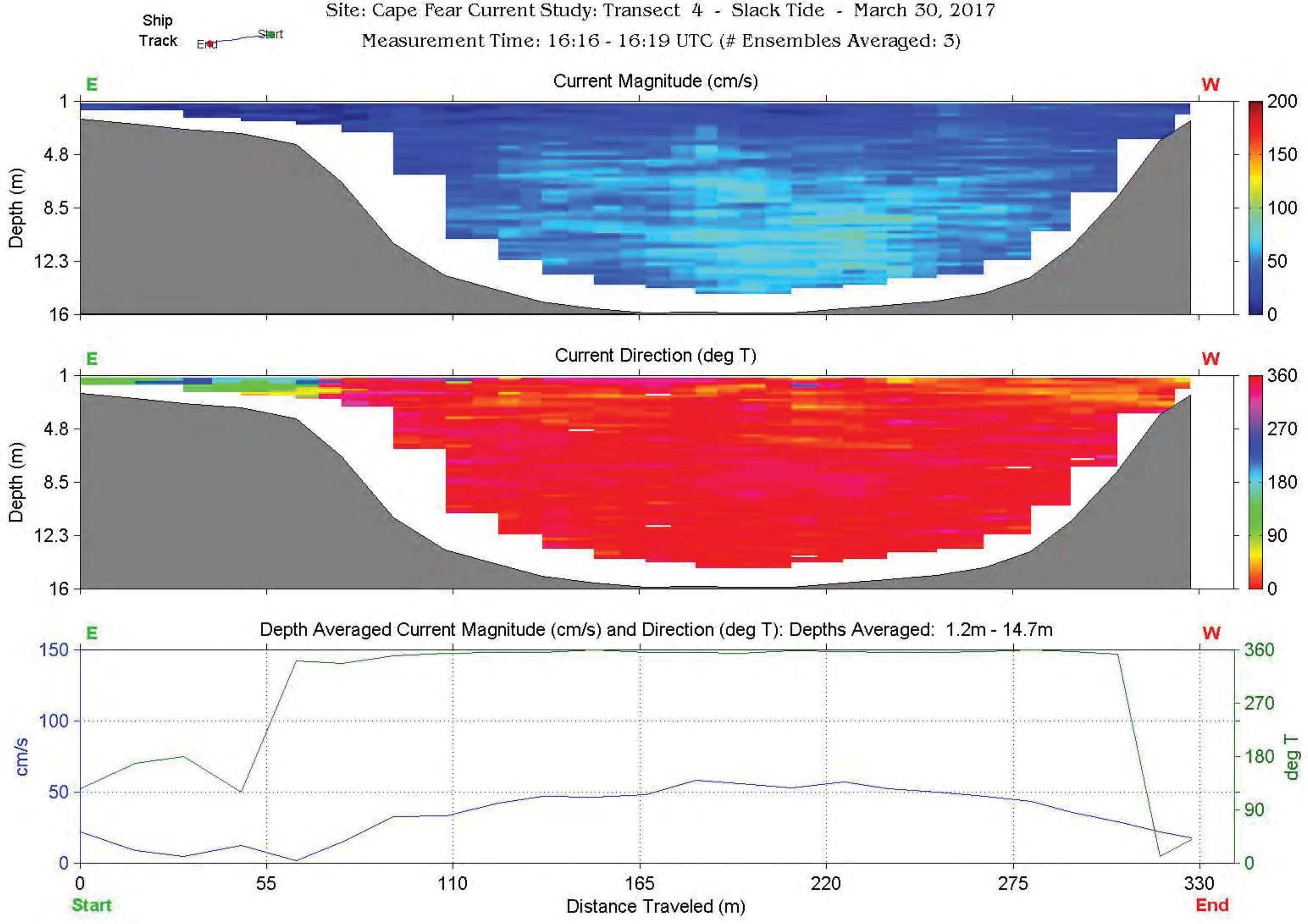
Site: Cape Fear Current Study: Transect 4 - Flood Tide - March 30, 2017

Measurement Time: 15:33 - 15:36 UTC (# Ensembles Averaged: 3)



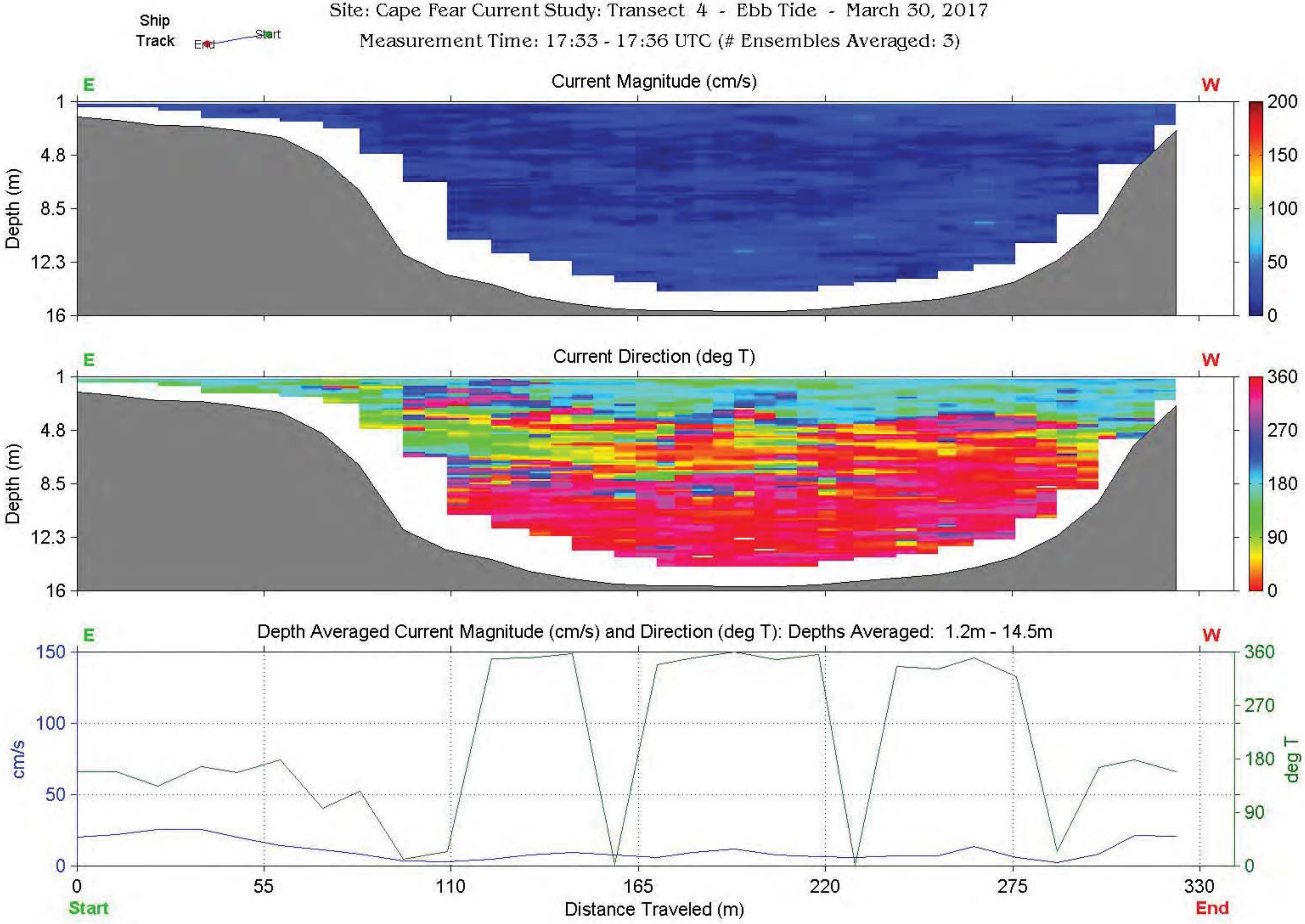
Site: Cape Fear Current Study: Transect 4 - Slack Tide - March 30, 2017

Measurement Time: 16:16 - 16:19 UTC (# Ensembles Averaged: 3)



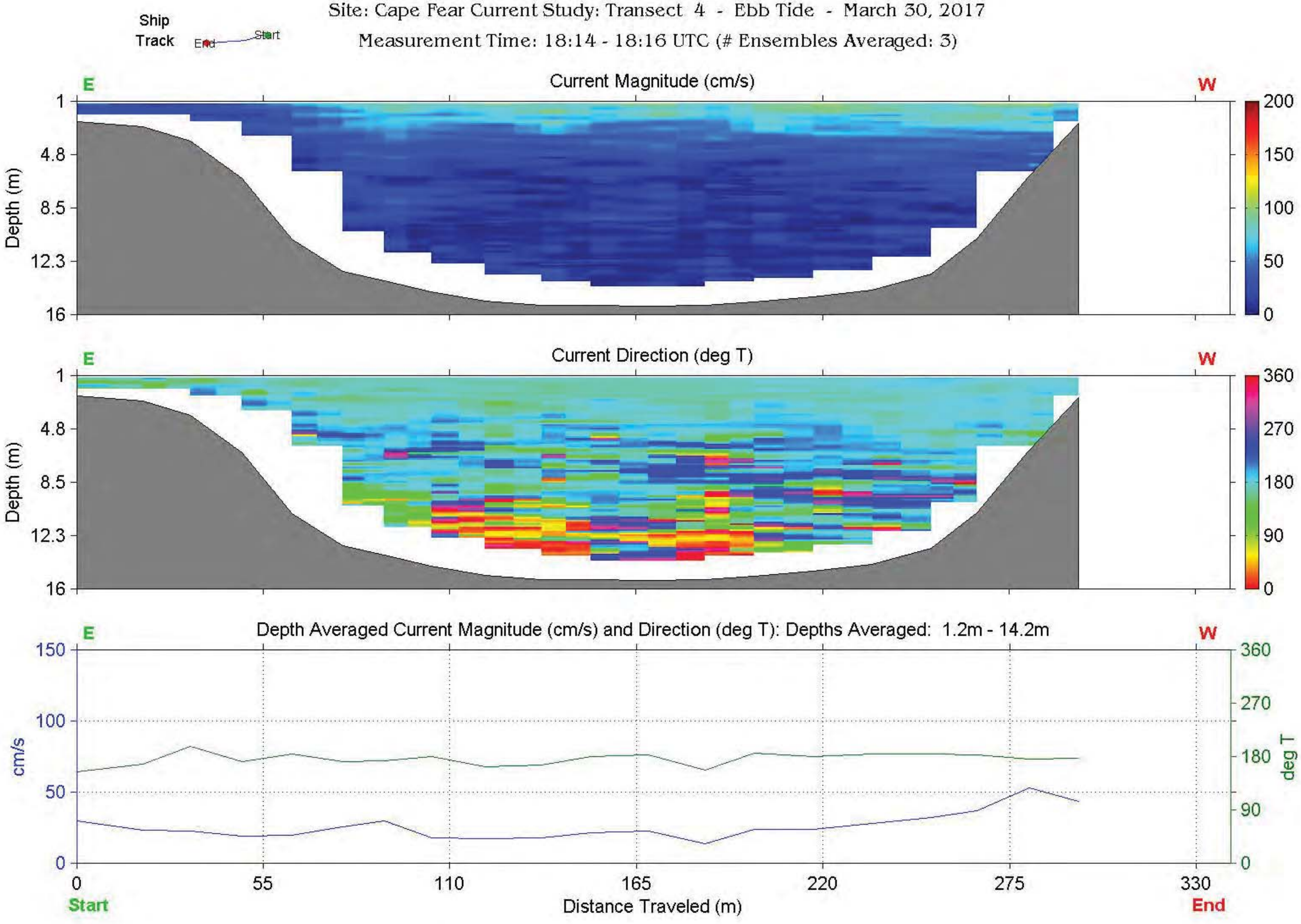
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 30, 2017

Measurement Time: 17:33 - 17:36 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 30, 2017

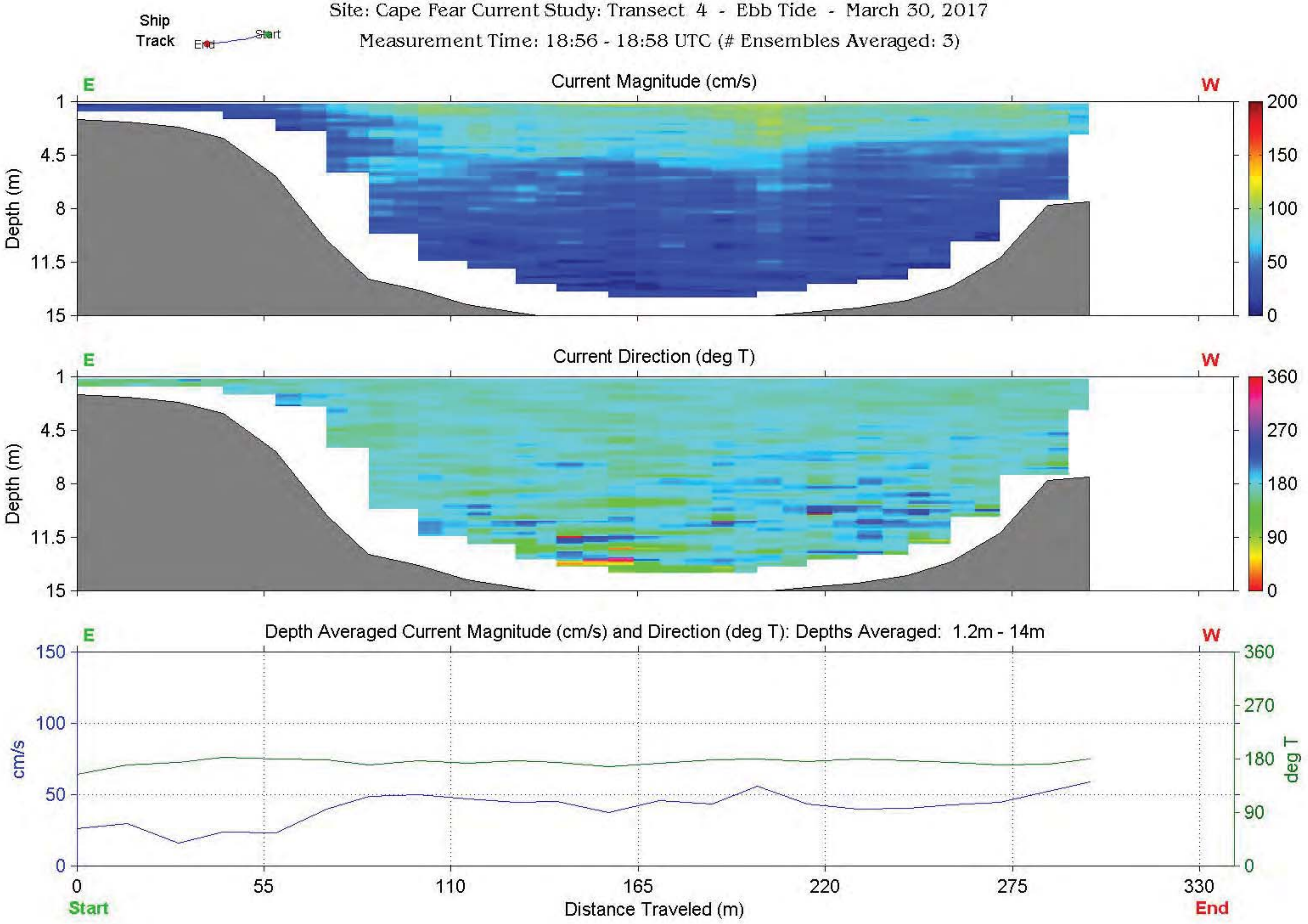
Measurement Time: 18:14 - 18:16 UTC (# Ensembles Averaged: 3)



Current Magnitude (cm/s)

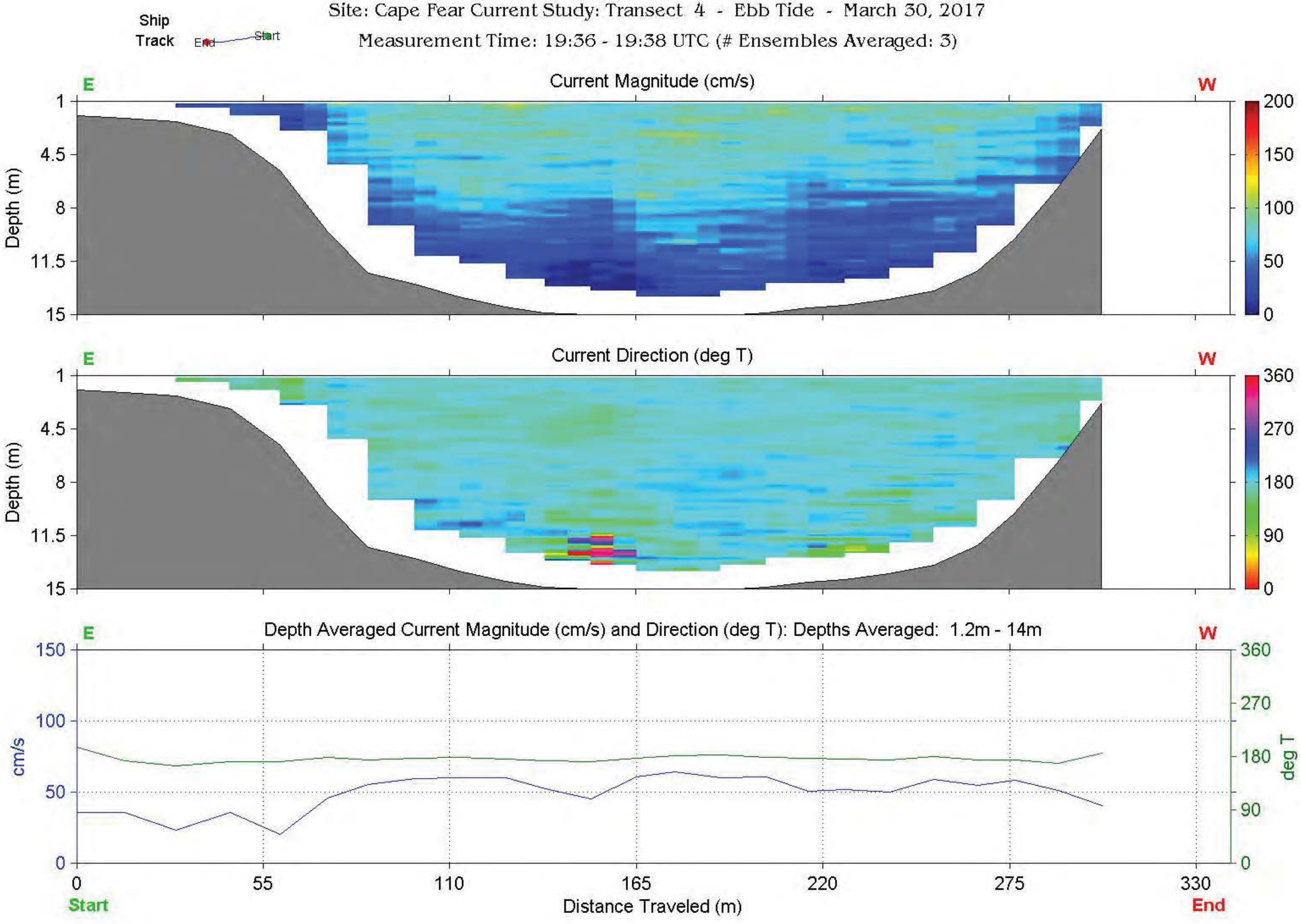
Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 14.2m



Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 30, 2017

Measurement Time: 18:56 - 18:58 UTC (# Ensembles Averaged: 3)

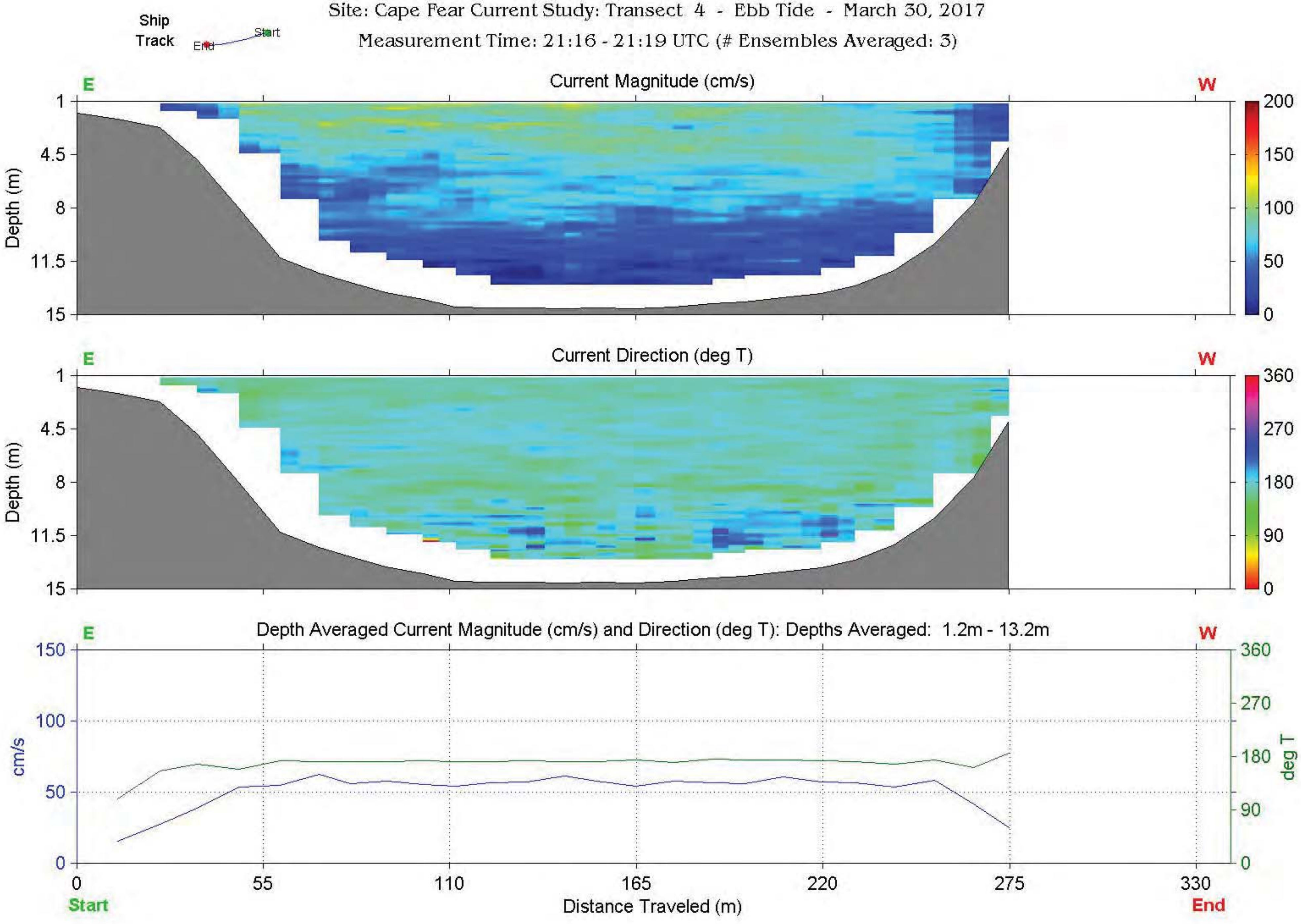


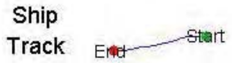
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 30, 2017

Measurement Time: 19:36 - 19:38 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 30, 2017

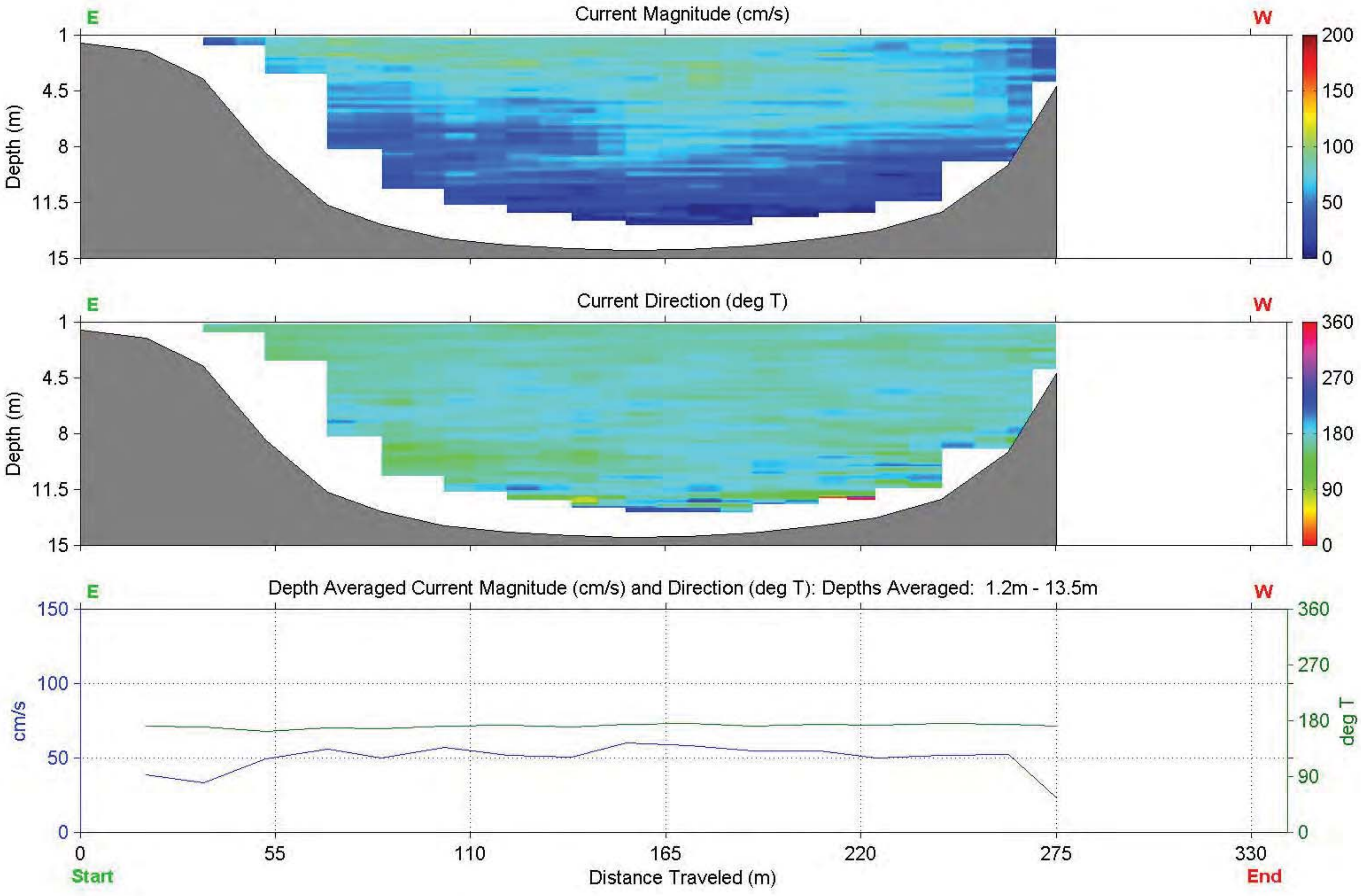
Measurement Time: 21:16 - 21:19 UTC (# Ensembles Averaged: 3)





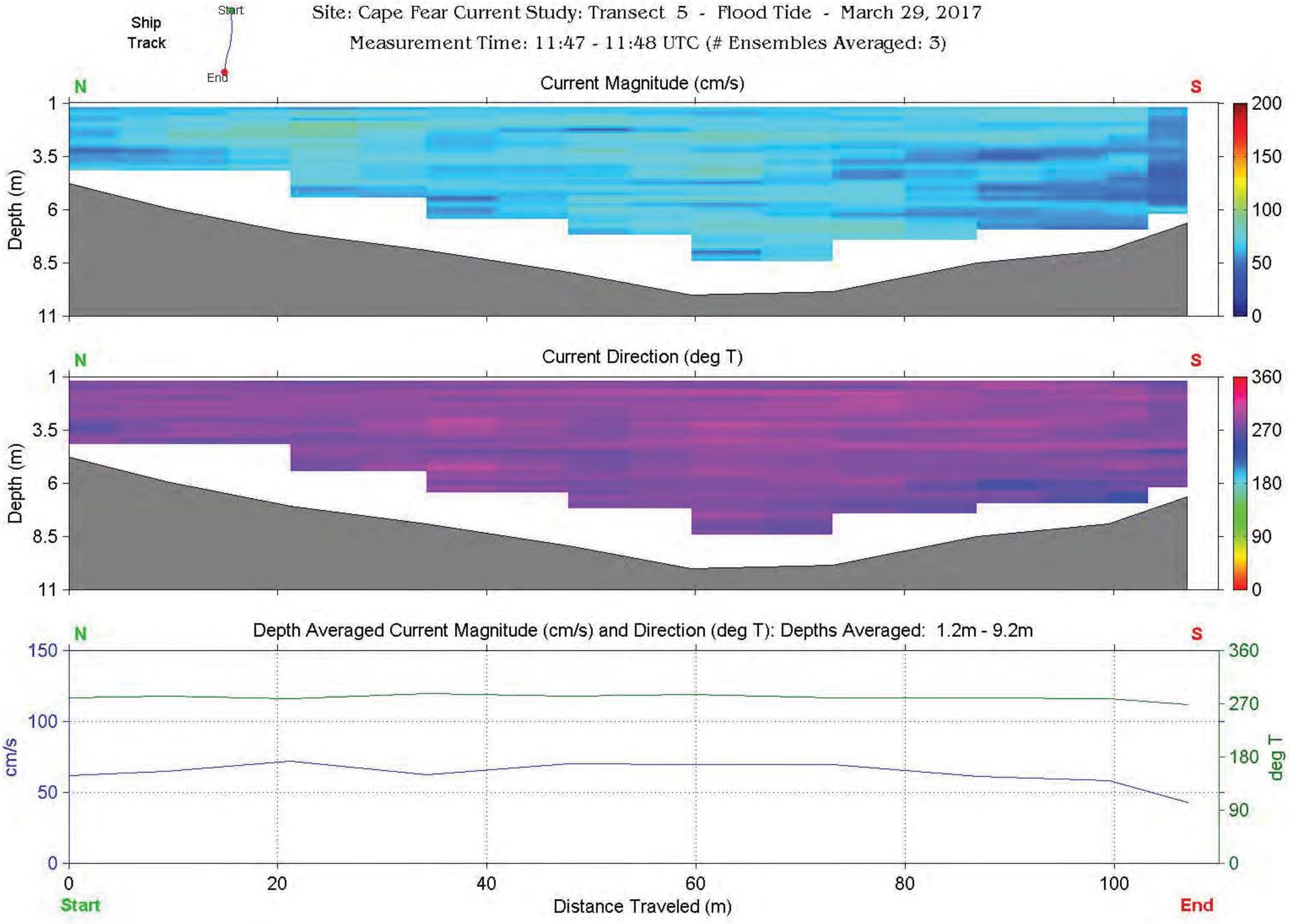
Site: Cape Fear Current Study: Transect 4 - Ebb Tide - March 30, 2017

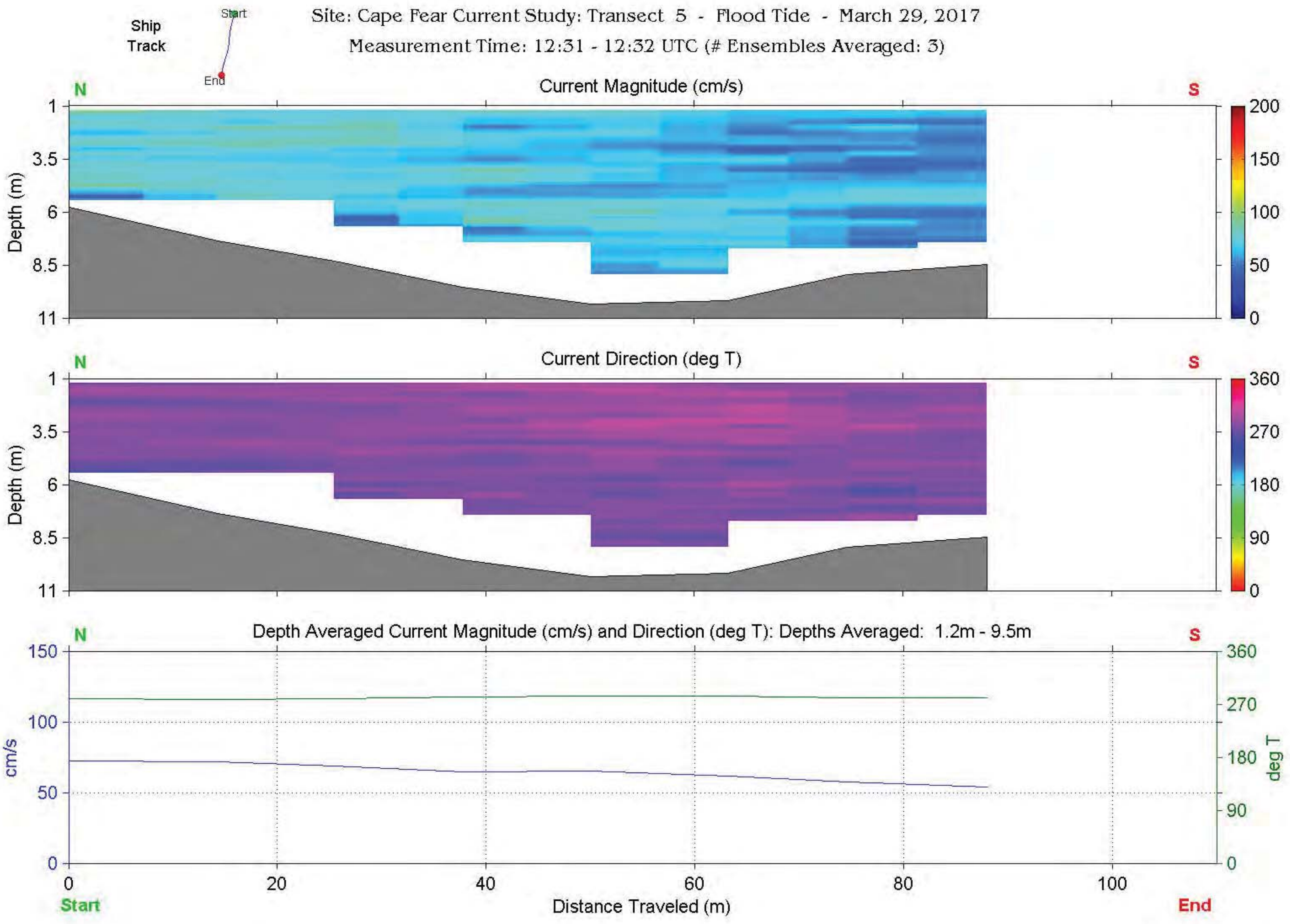
Measurement Time: 21:57 - 21:59 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 29, 2017

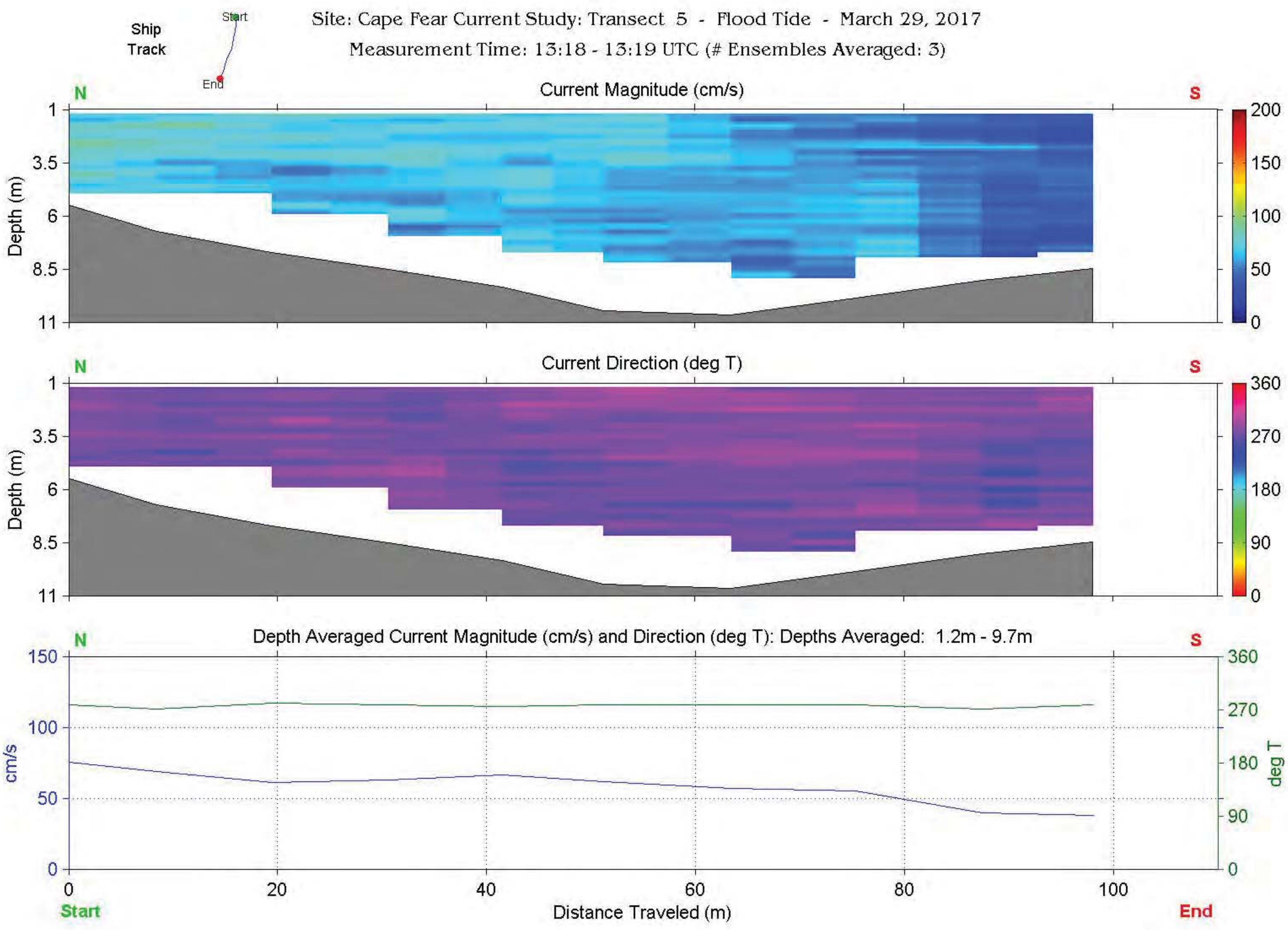
Measurement Time: 11:47 - 11:48 UTC (# Ensembles Averaged: 3)



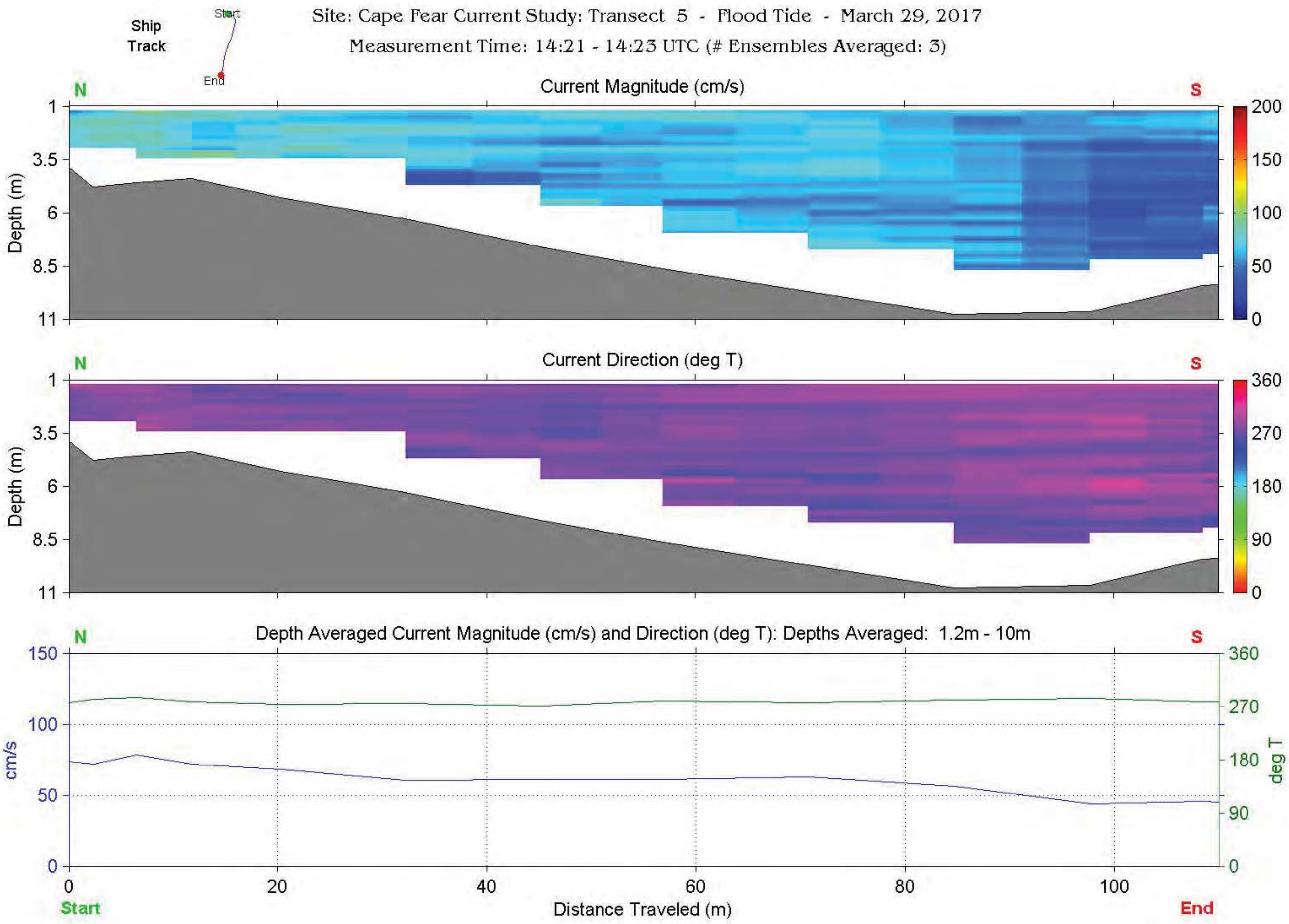


Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 29, 2017

Measurement Time: 12:31 - 12:32 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 29, 2017

Measurement Time: 13:18 - 13:19 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 29, 2017

Measurement Time: 14:21 - 14:23 UTC (# Ensembles Averaged: 3)

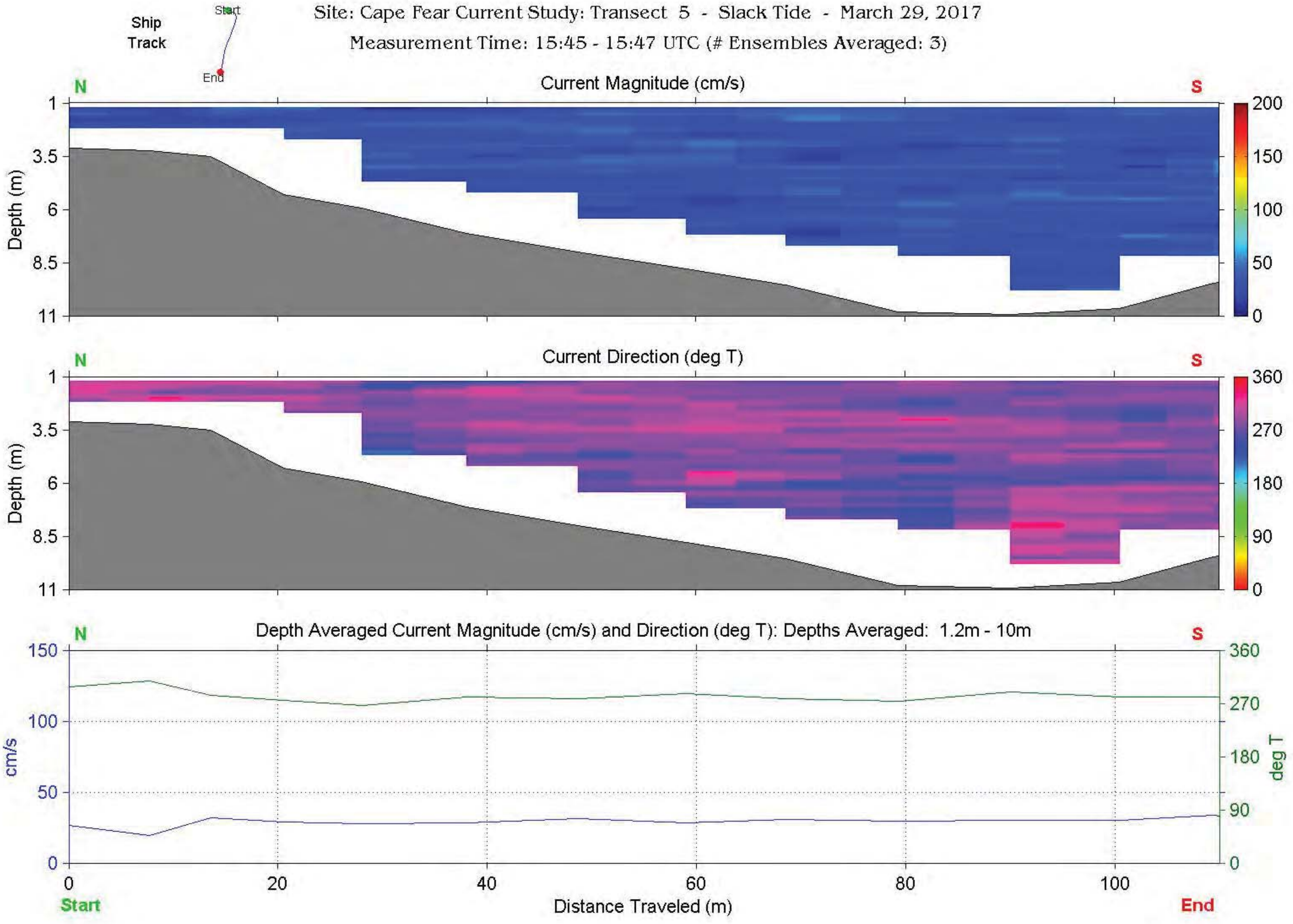
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 10m

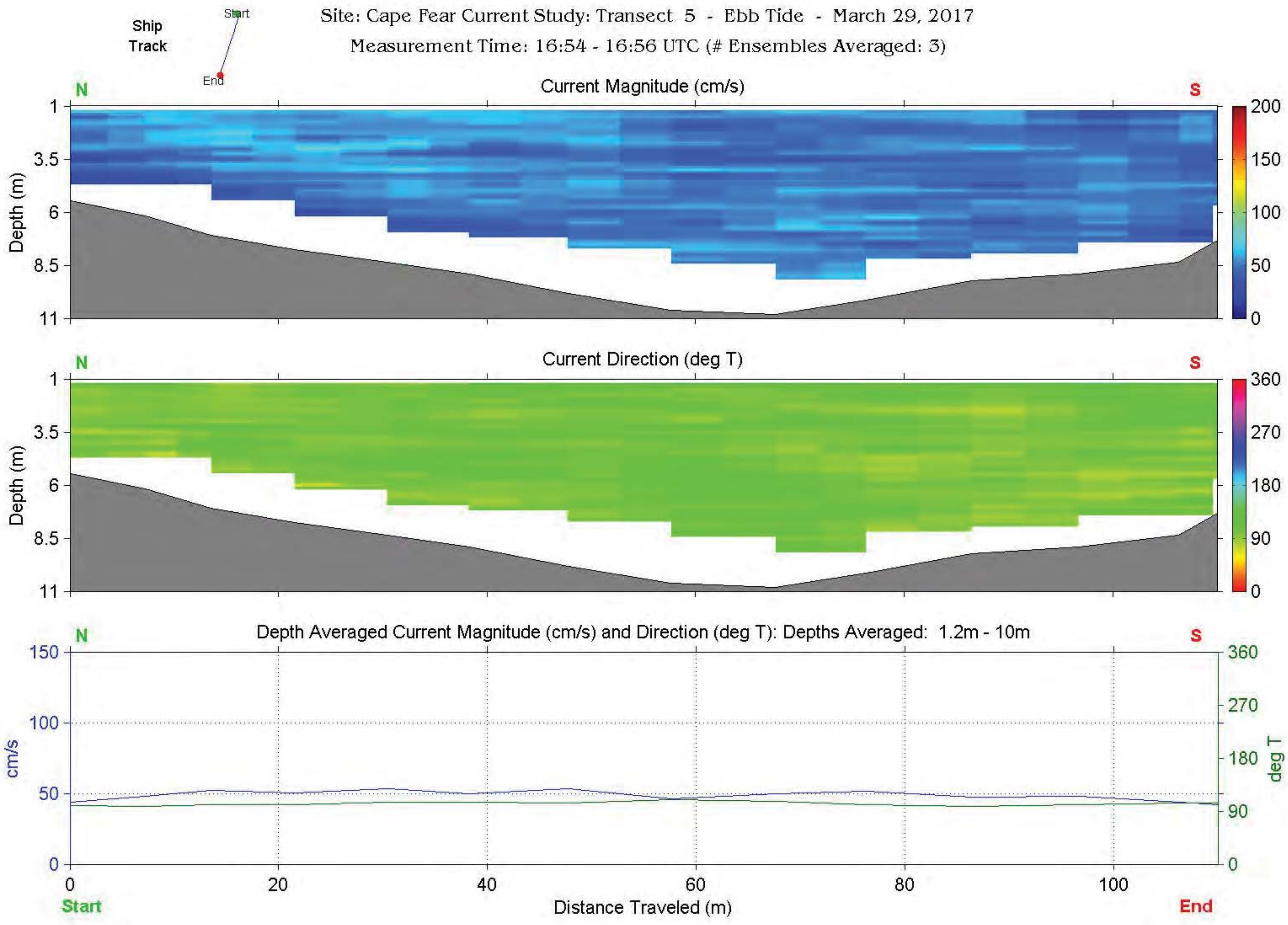
Site: Cape Fear Current Study: Transect 5 - Slack Tide - March 29, 2017

Measurement Time: 15:45 - 15:47 UTC (# Ensembles Averaged: 3)



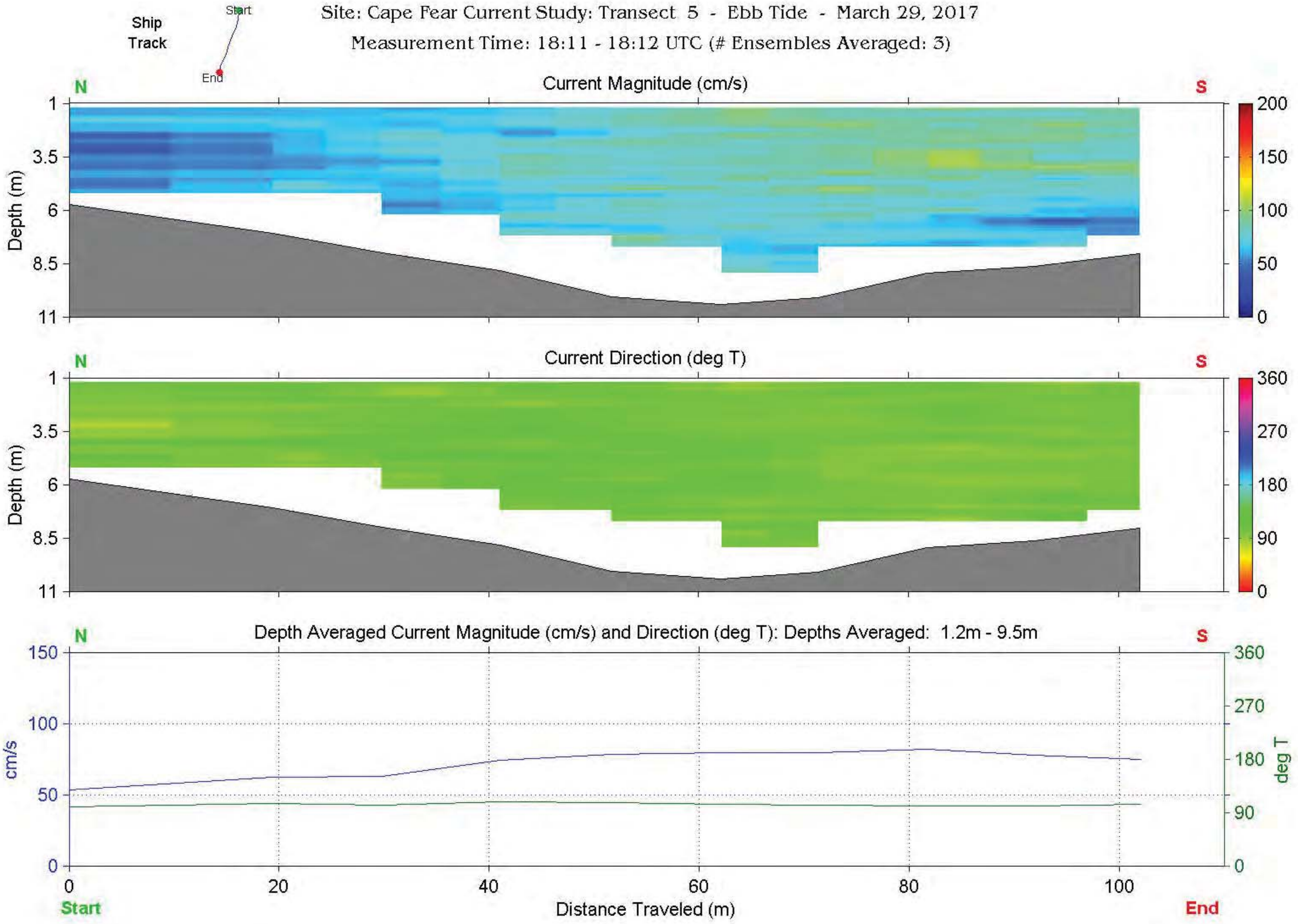
Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 29, 2017

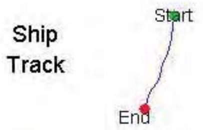
Measurement Time: 16:54 - 16:56 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 29, 2017

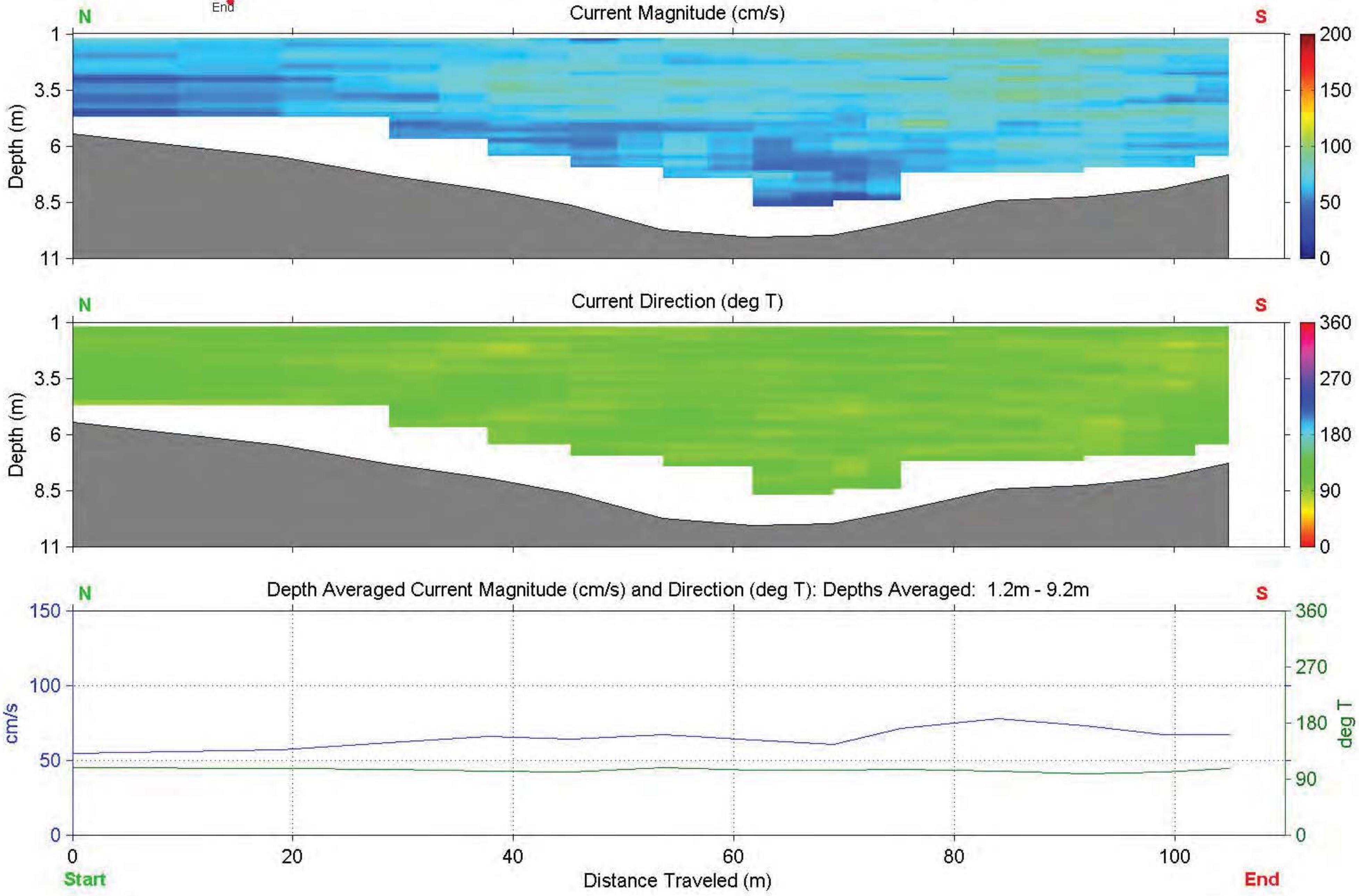
Measurement Time: 18:11 - 18:12 UTC (# Ensembles Averaged: 3)





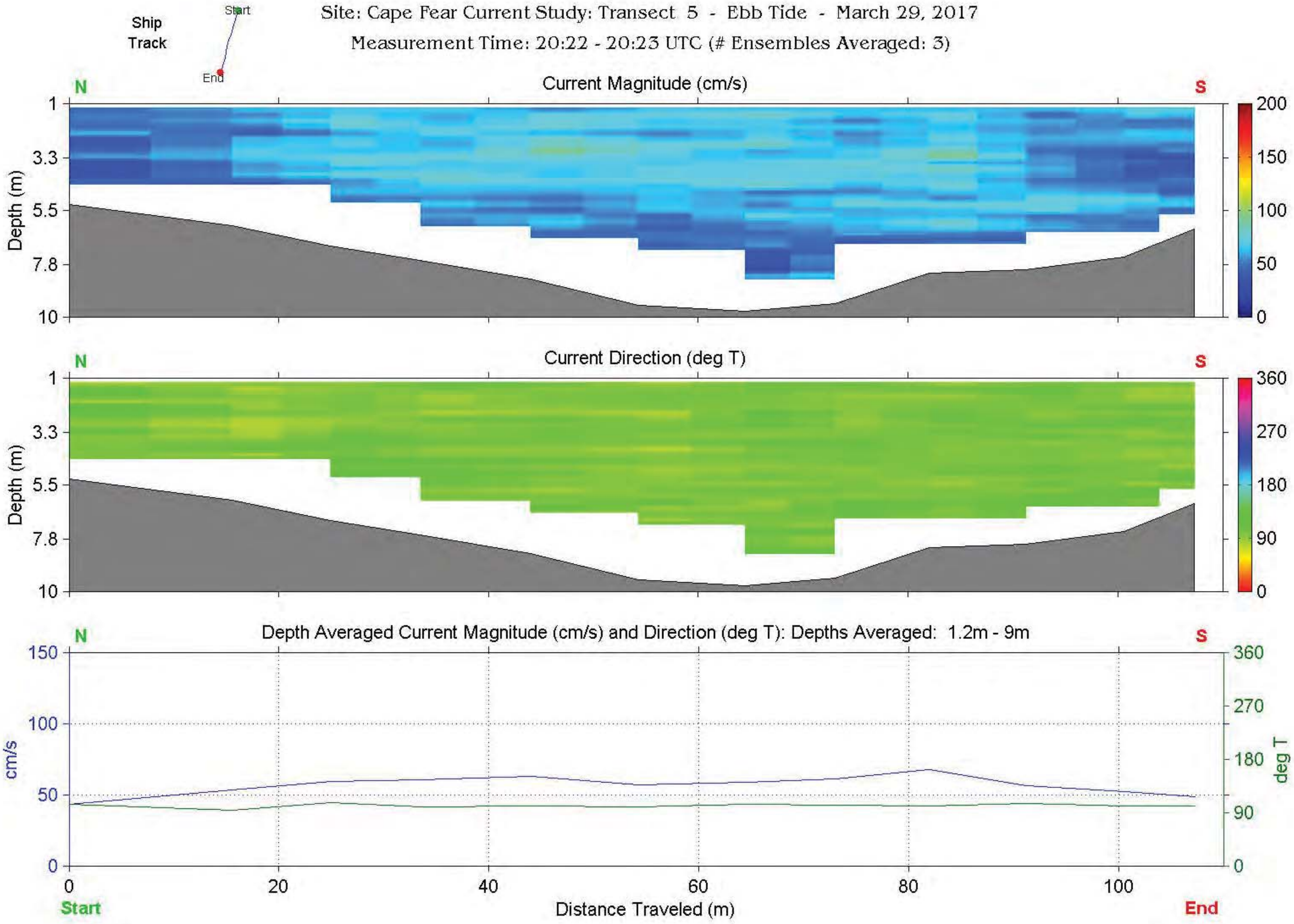
Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 29, 2017

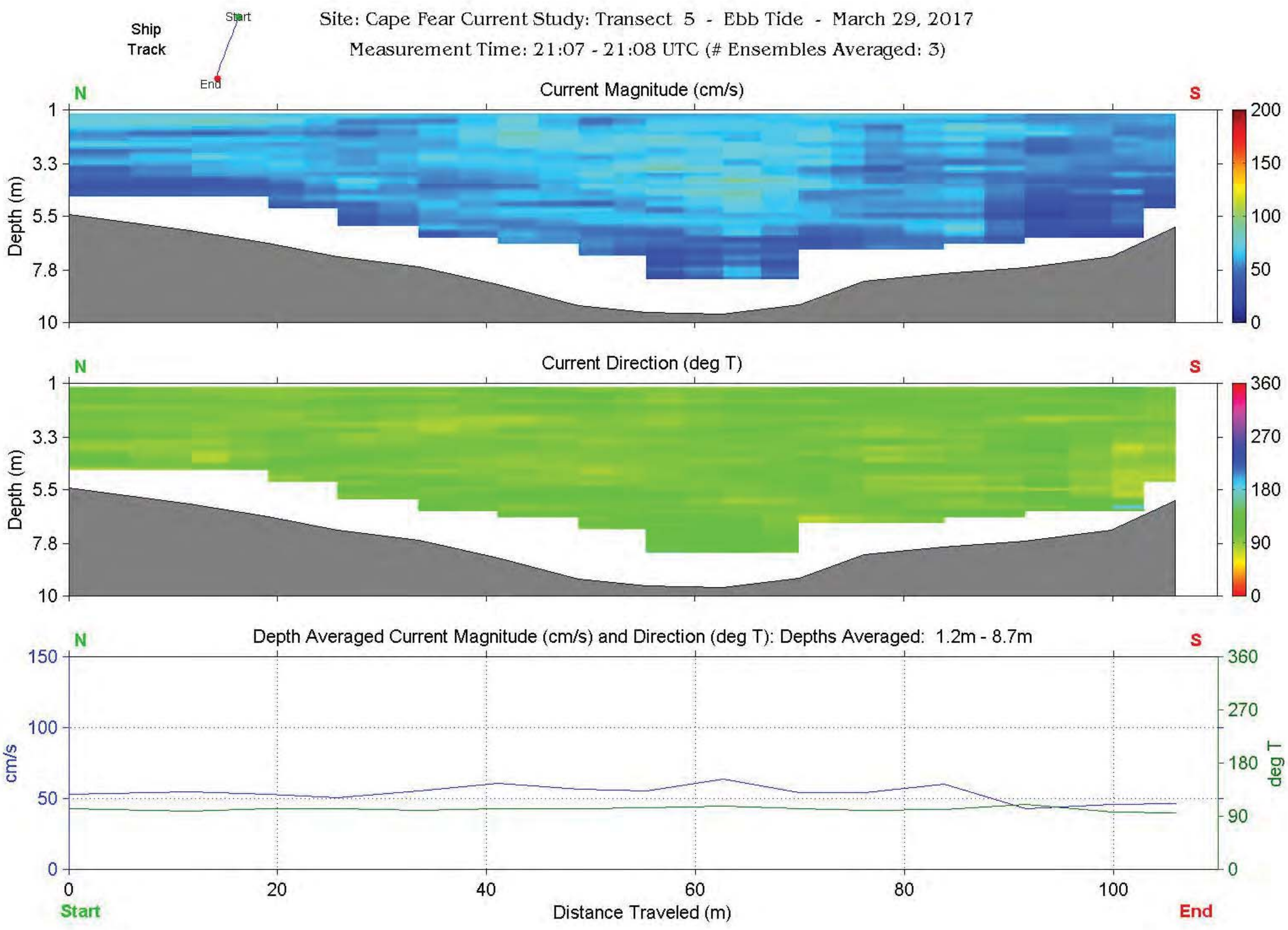
Measurement Time: 19:36 - 19:37 UTC (# Ensembles Averaged: 3)



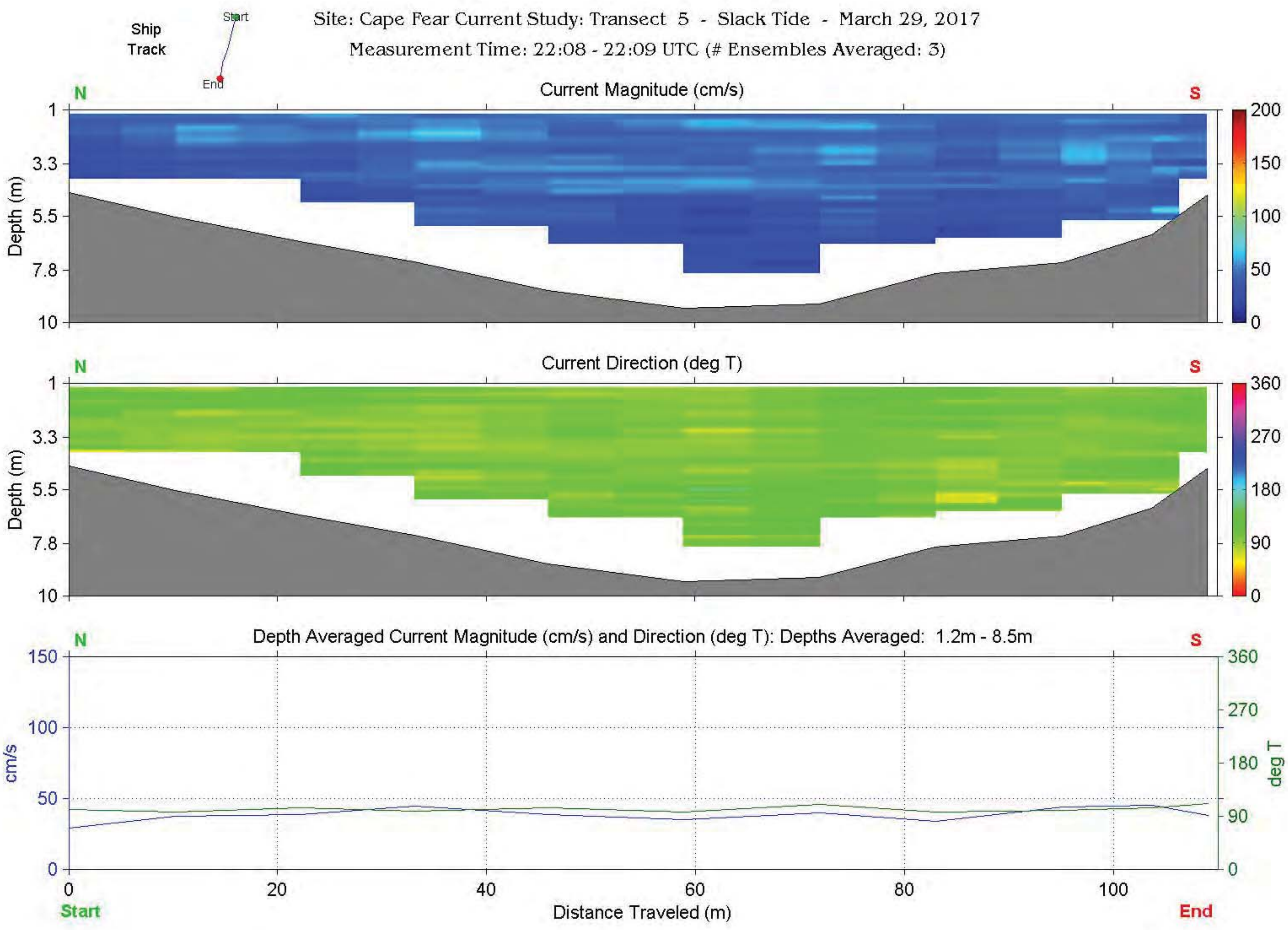
Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 29, 2017

Measurement Time: 20:22 - 20:23 UTC (# Ensembles Averaged: 3)



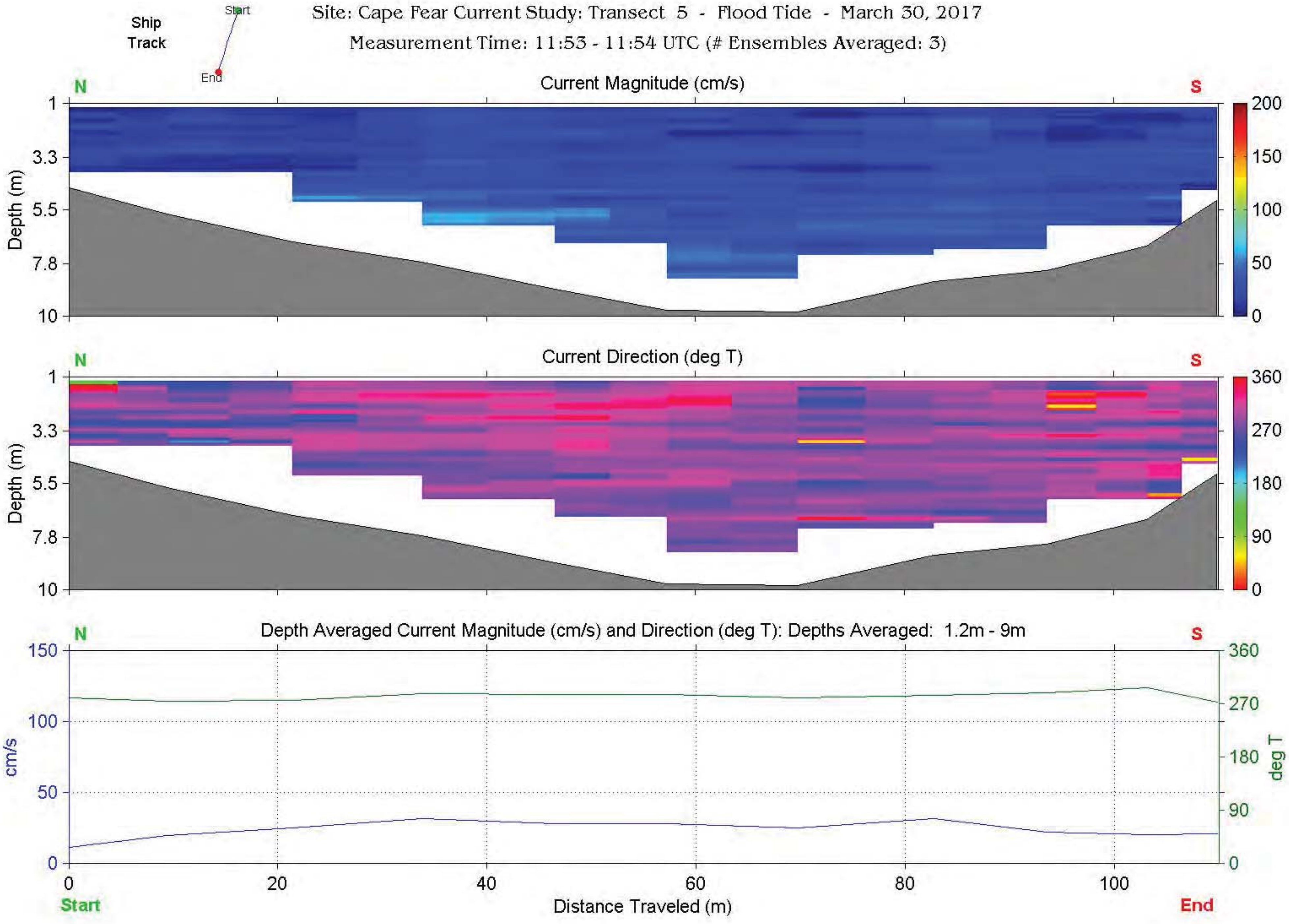

Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 29, 2017

Measurement Time: 21:07 - 21:08 UTC (# Ensembles Averaged: 3)

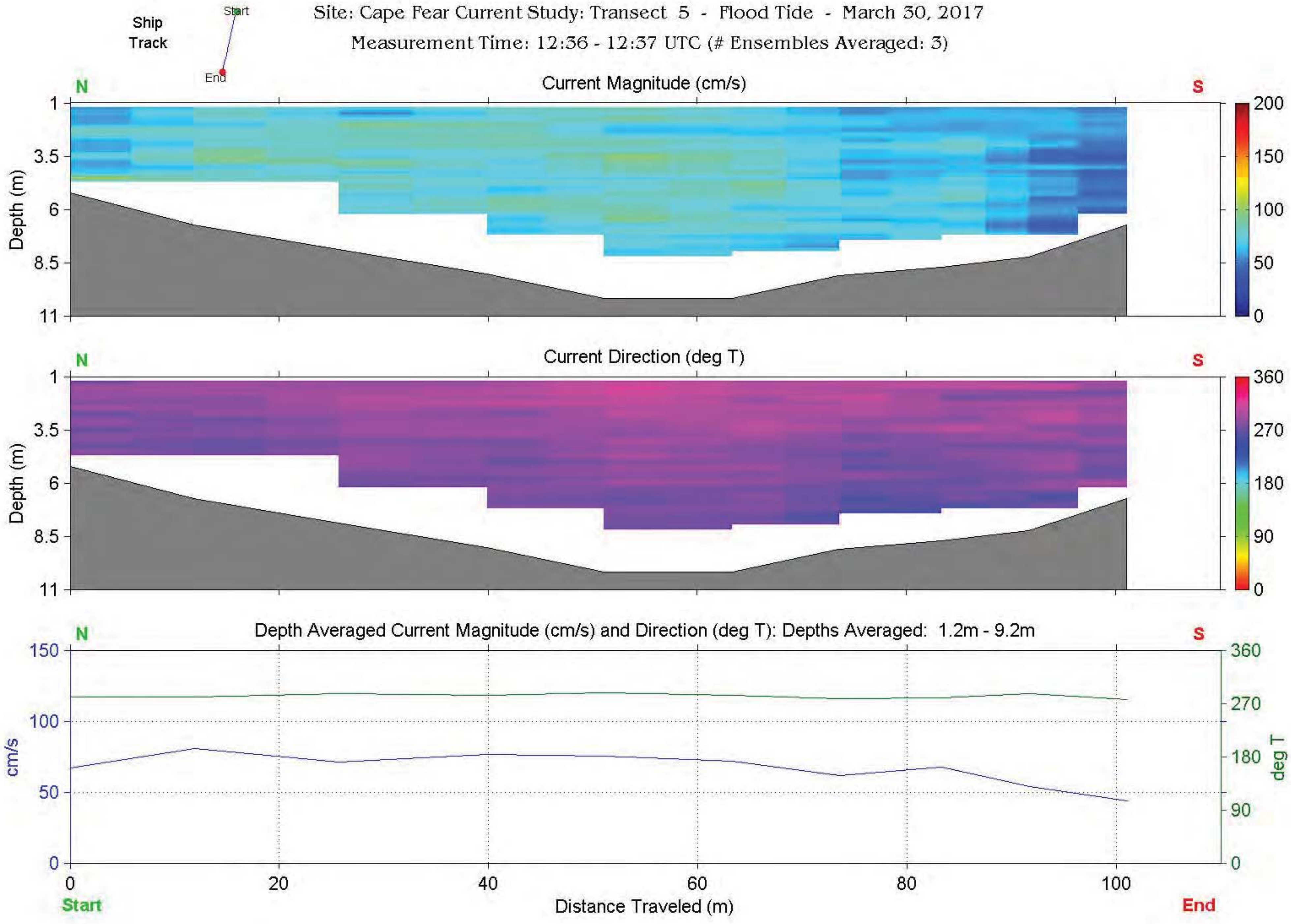


Site: Cape Fear Current Study: Transect 5 - Slack Tide - March 29, 2017

Measurement Time: 22:08 - 22:09 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 30, 2017

Measurement Time: 11:53 - 11:54 UTC (# Ensembles Averaged: 3)

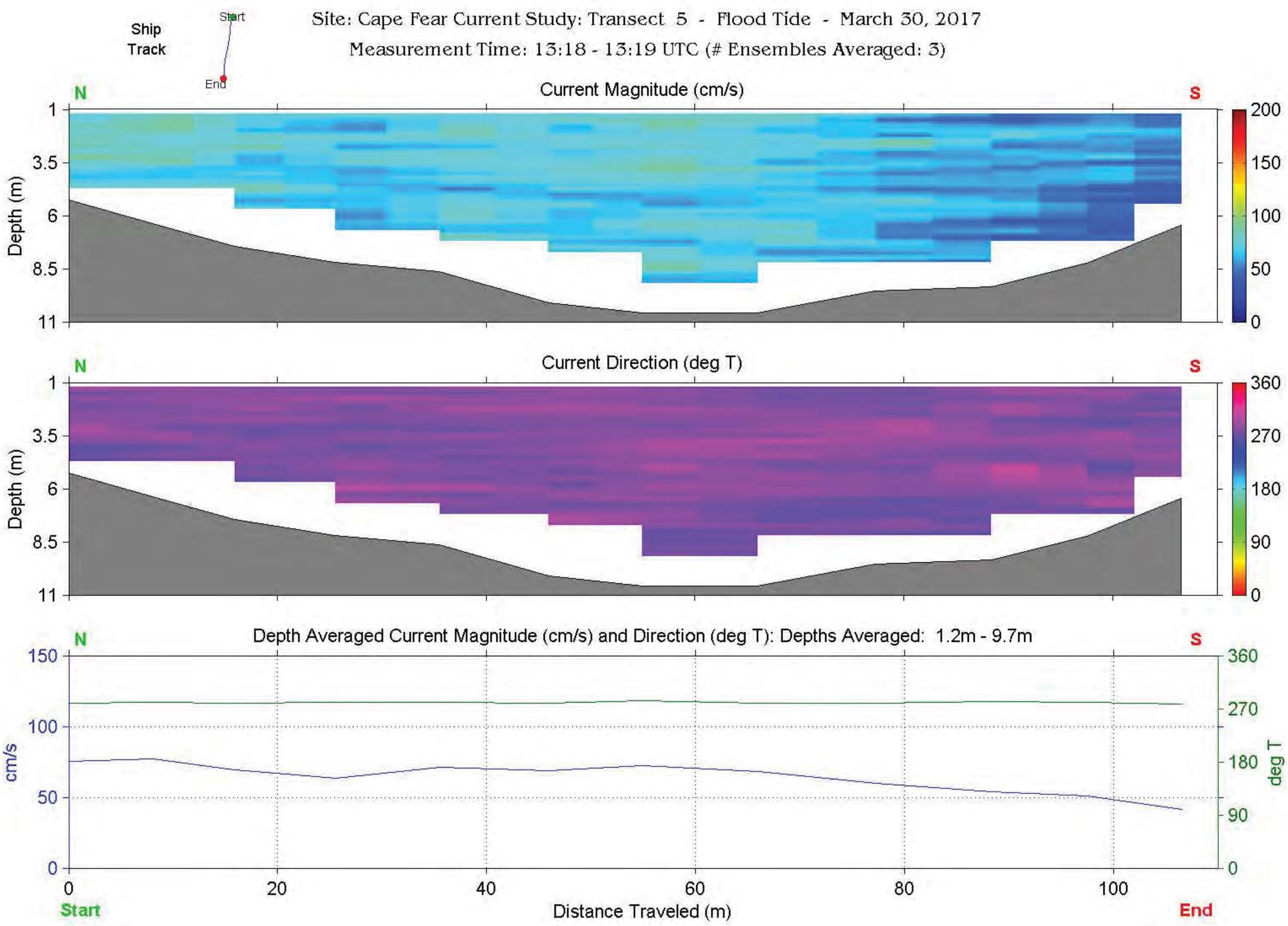


Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 30, 2017

Measurement Time: 12:36 - 12:37 UTC (# Ensembles Averaged: 3)

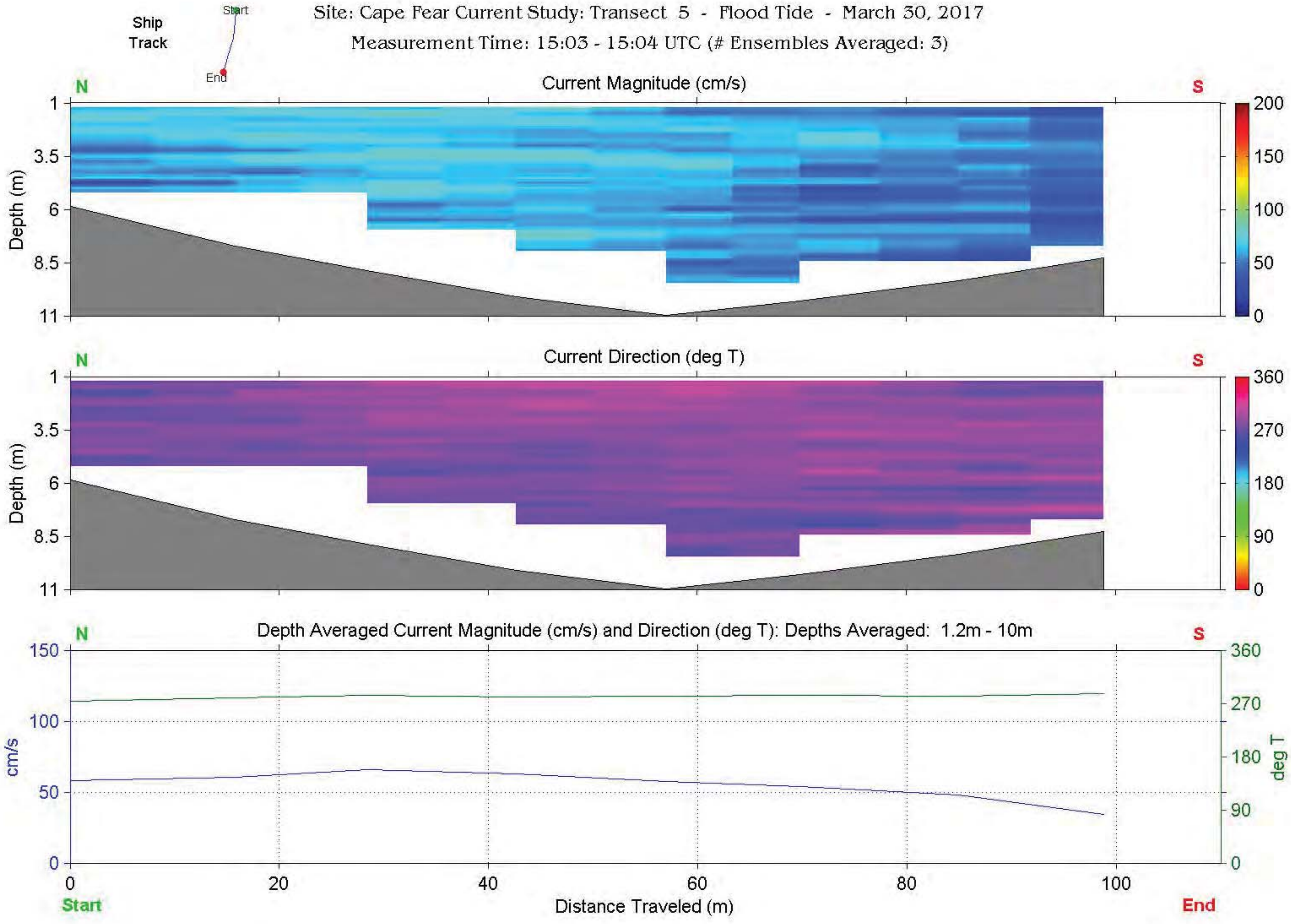
Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 30, 2017

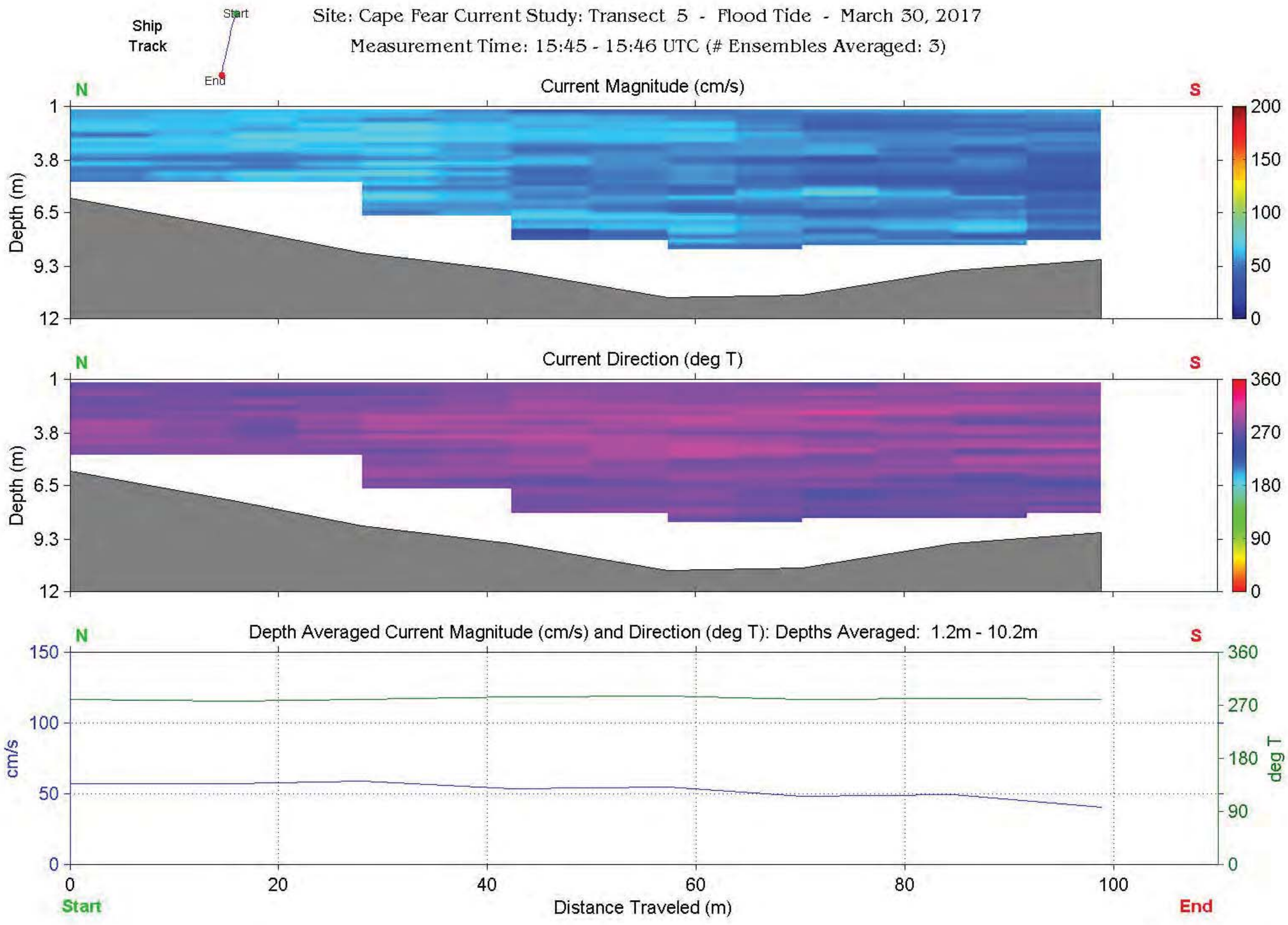
Measurement Time: 13:18 - 13:19 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 30, 2017

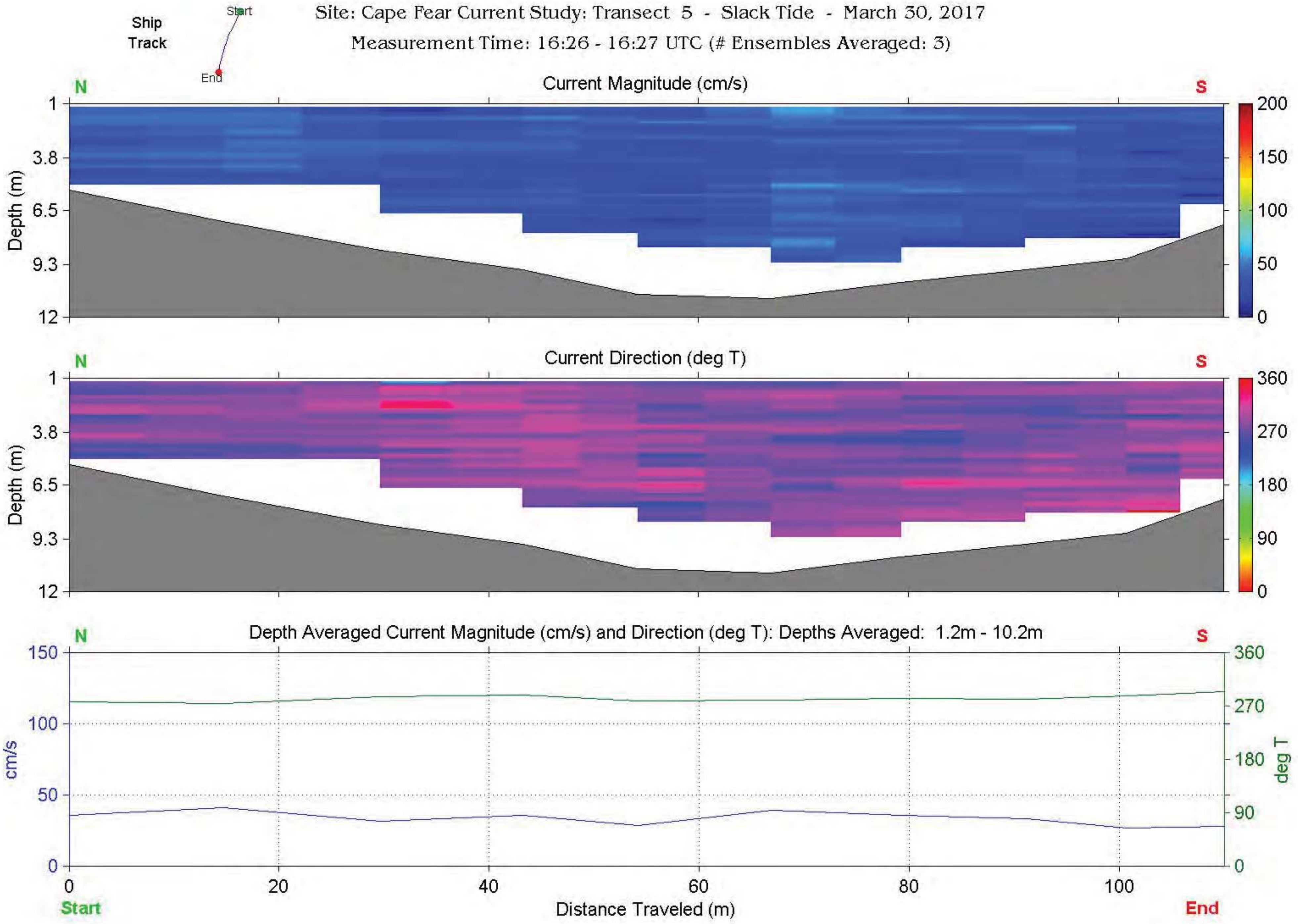
Measurement Time: 15:03 - 15:04 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 5 - Flood Tide - March 30, 2017

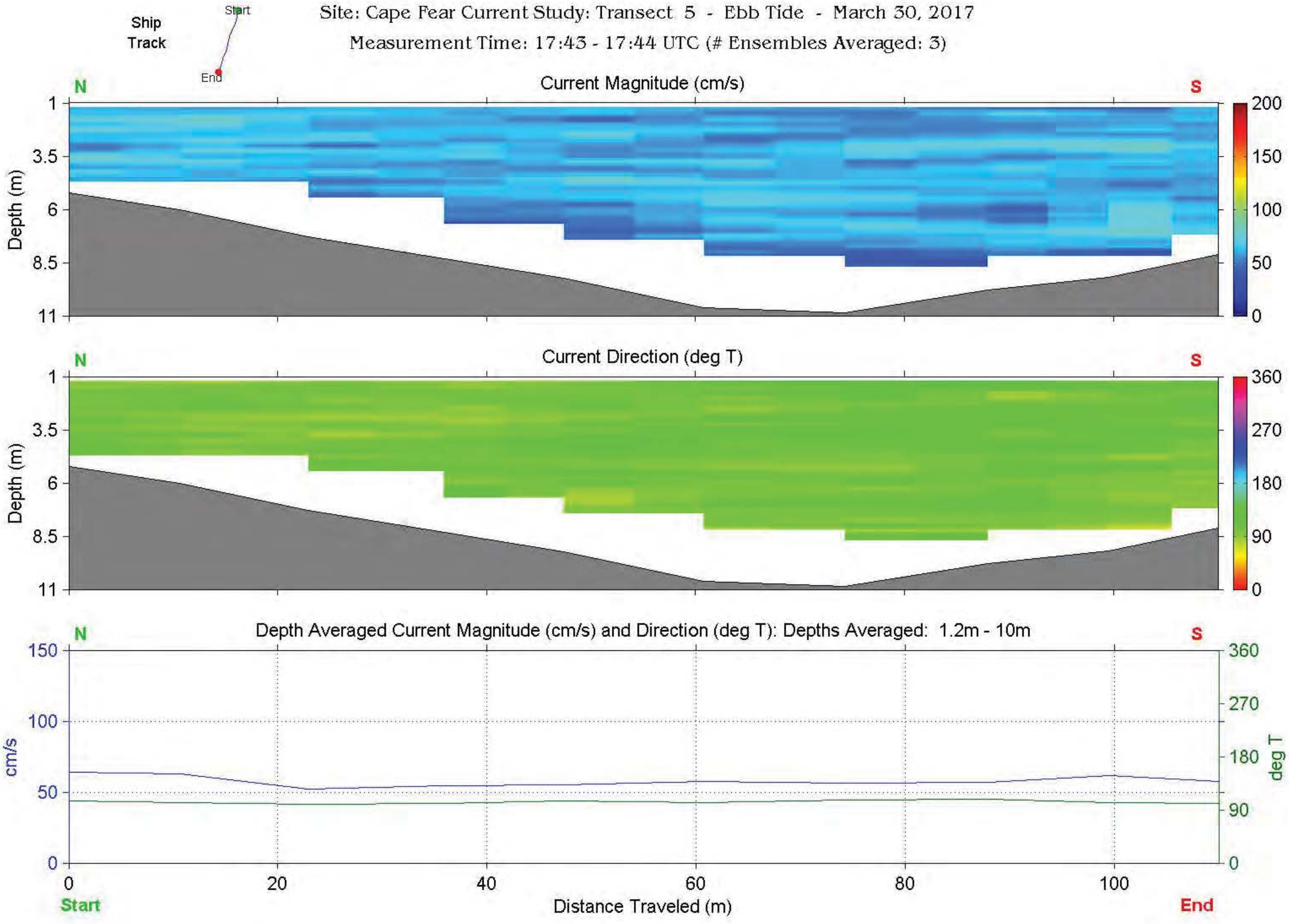
Measurement Time: 15:45 - 15:46 UTC (# Ensembles Averaged: 3)

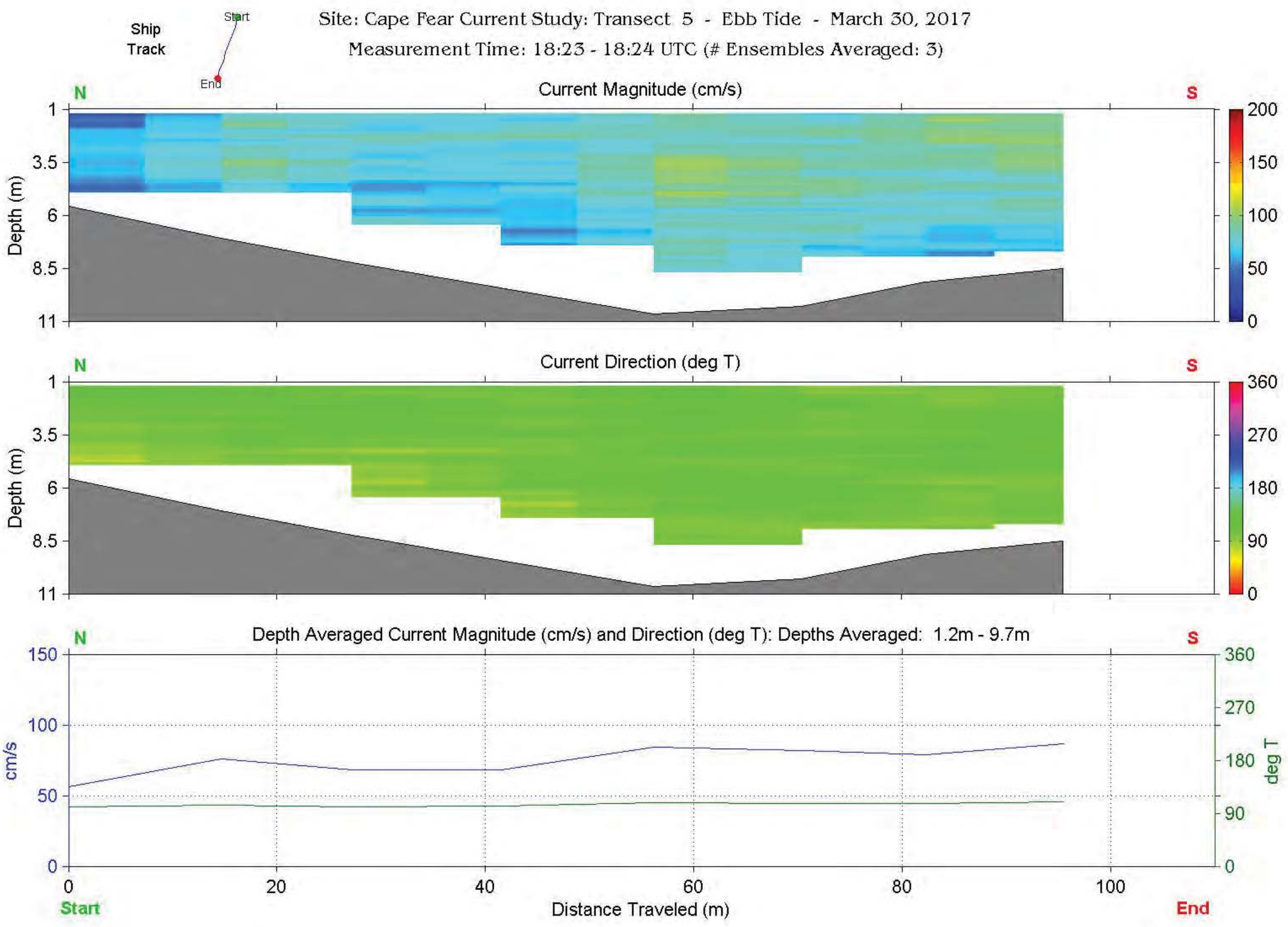

Site: Cape Fear Current Study: Transect 5 - Slack Tide - March 30, 2017

Measurement Time: 16:26 - 16:27 UTC (# Ensembles Averaged: 3)

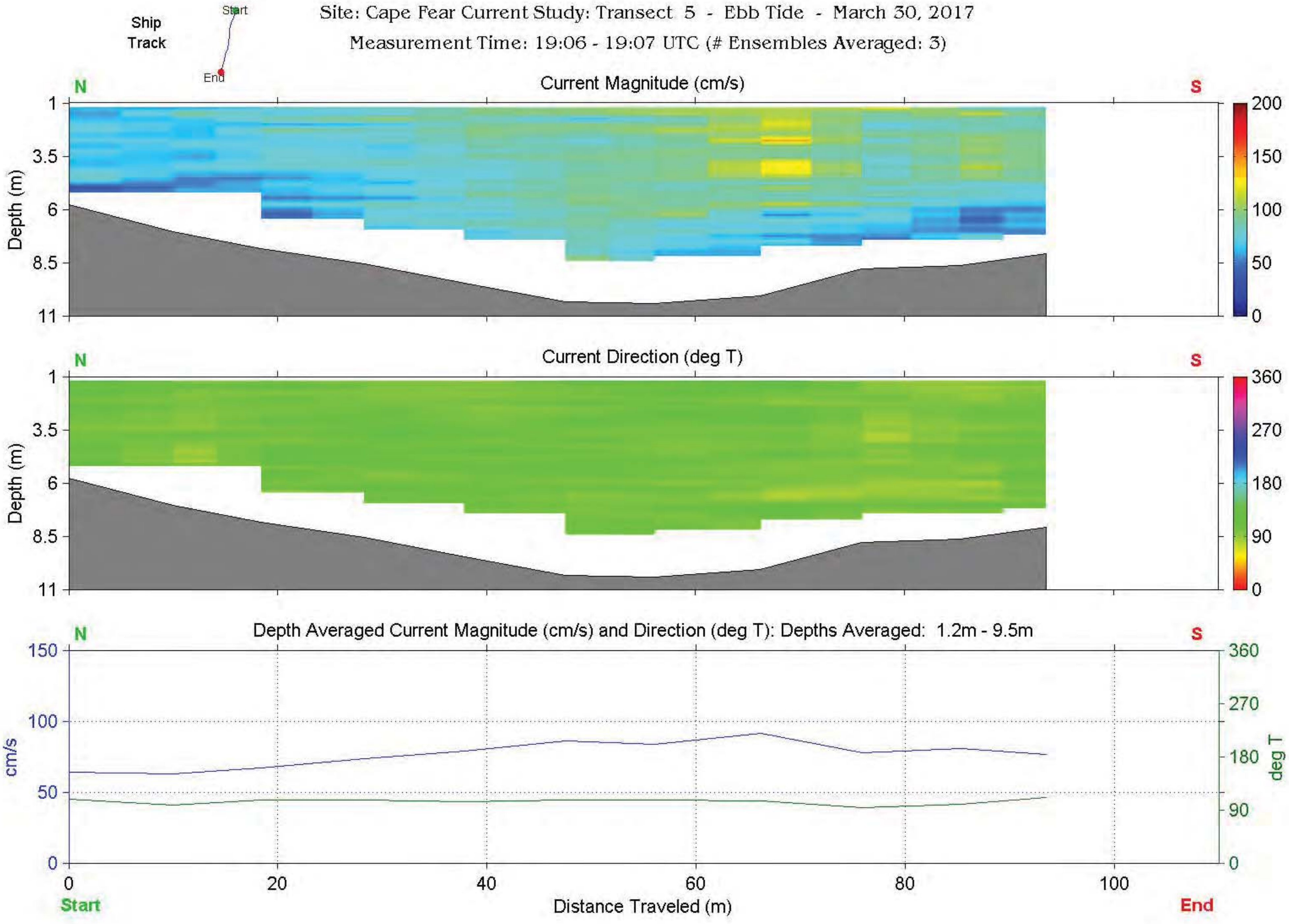
Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 30, 2017

Measurement Time: 17:43 - 17:44 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 30, 2017

Measurement Time: 18:23 - 18:24 UTC (# Ensembles Averaged: 3)

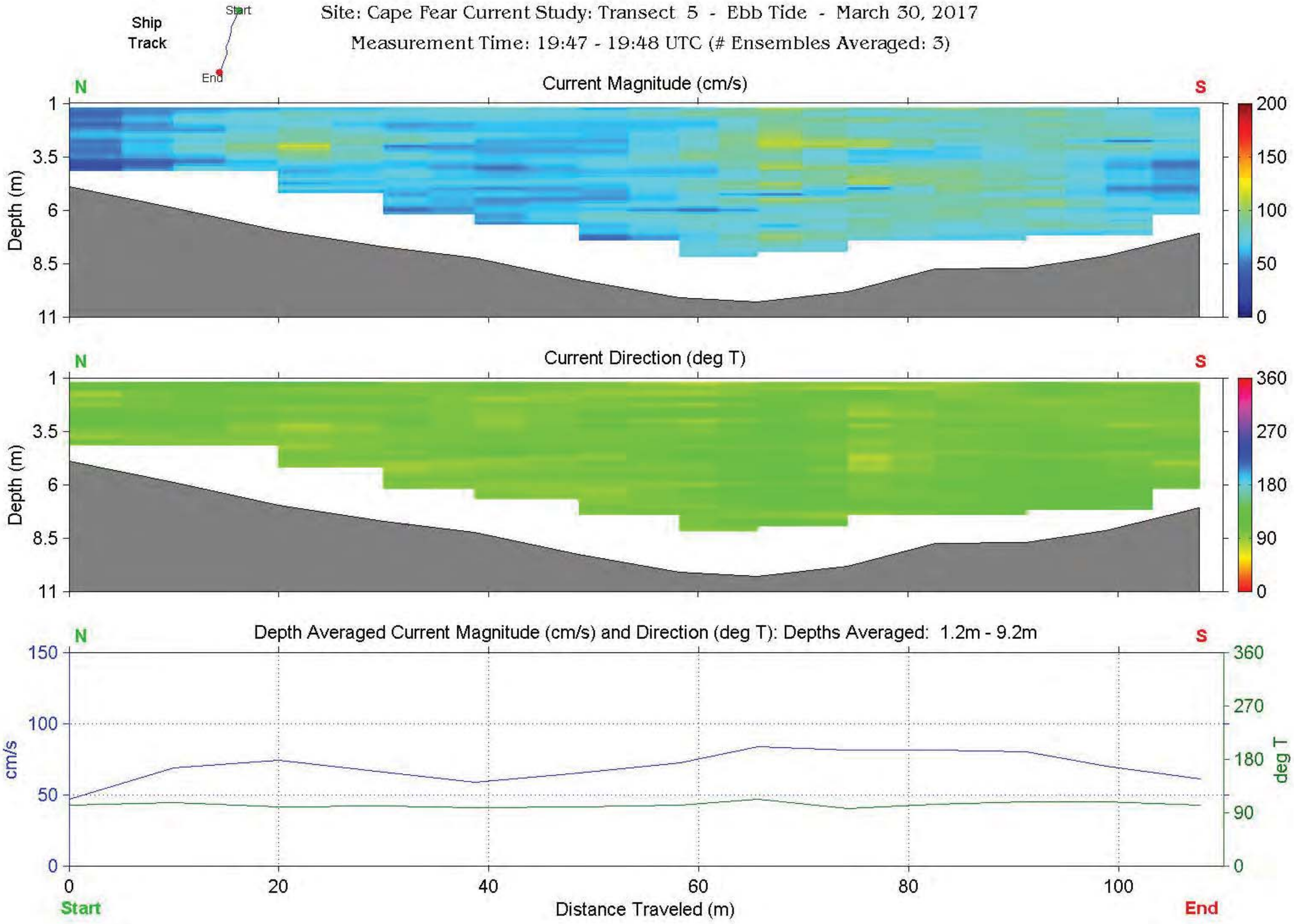

Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 30, 2017

Measurement Time: 19:06 - 19:07 UTC (# Ensembles Averaged: 3)

Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 9.5m

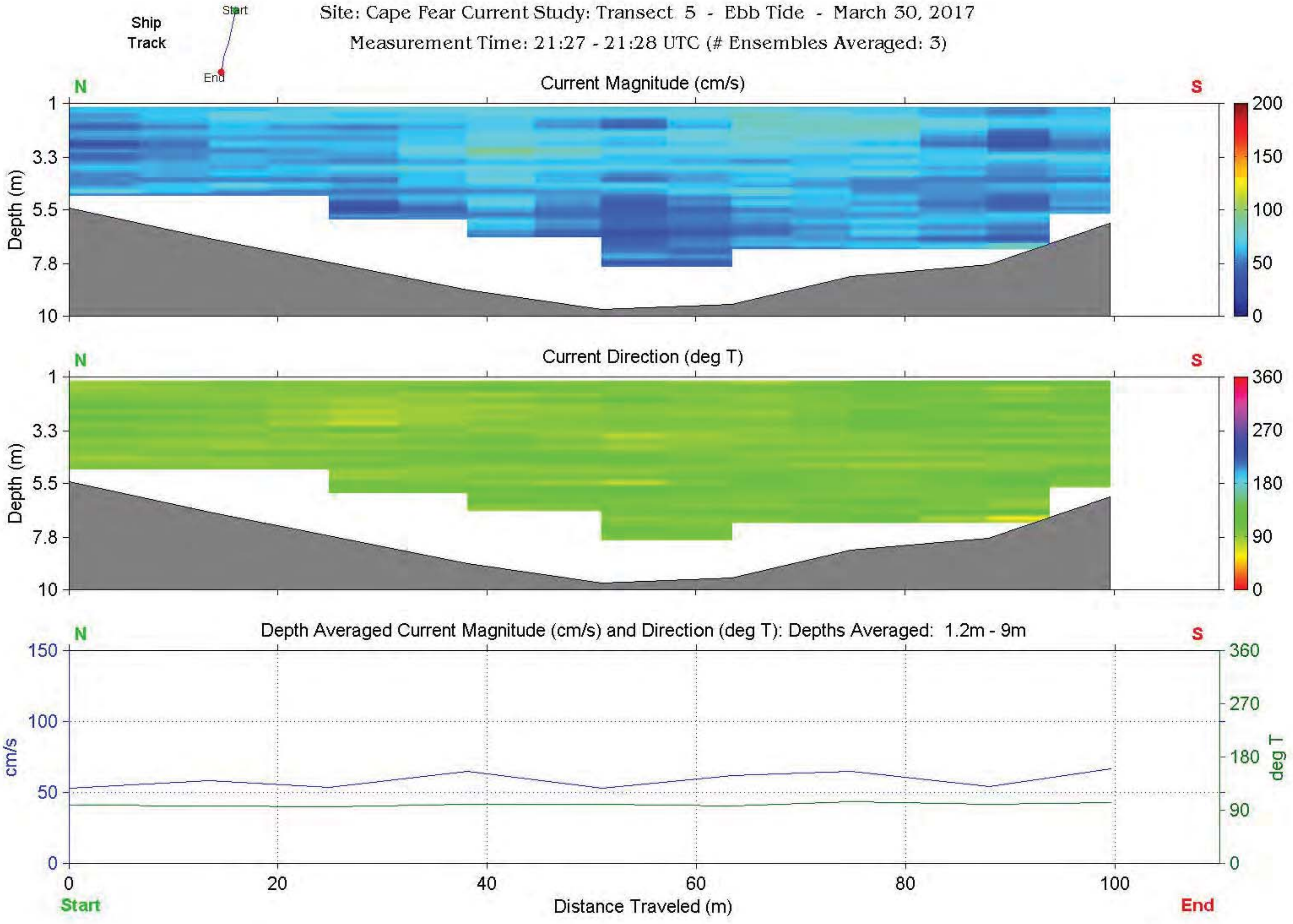


Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 30, 2017

Measurement Time: 19:47 - 19:48 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 30, 2017

Measurement Time: 21:27 - 21:28 UTC (# Ensembles Averaged: 3)



Current Magnitude (cm/s)

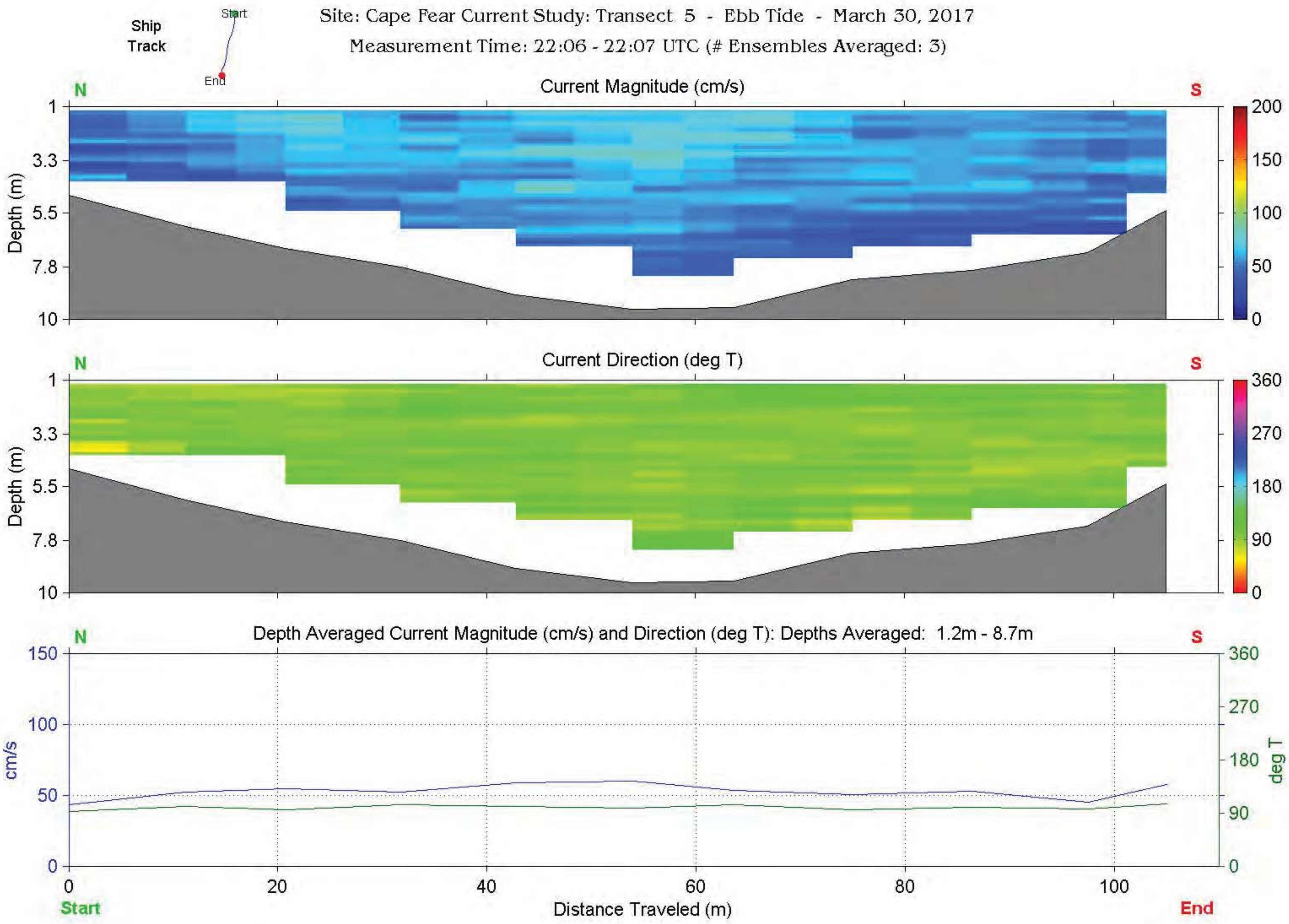
Current Direction (deg T)

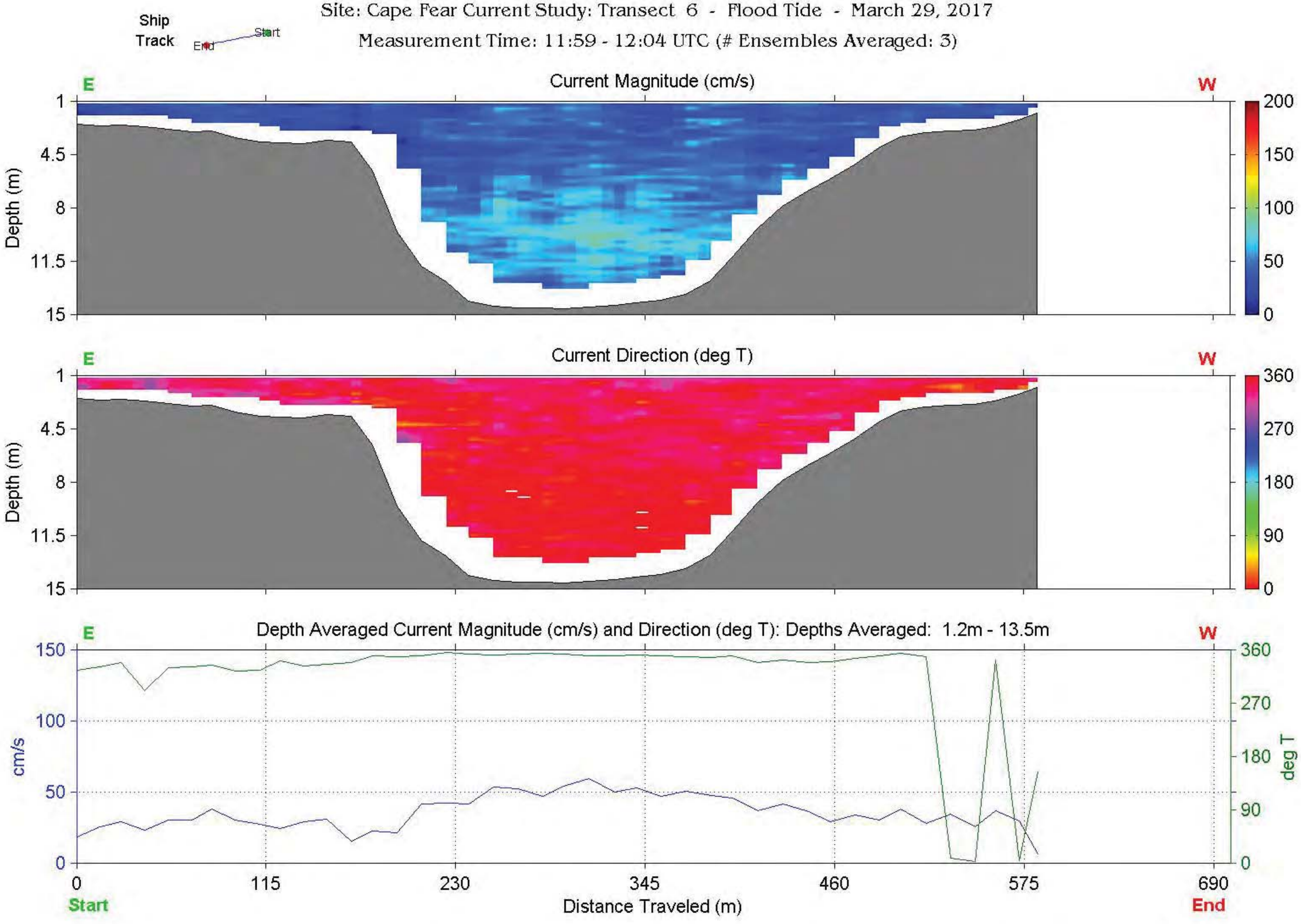
Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 9m

Distance Traveled (m)

Site: Cape Fear Current Study: Transect 5 - Ebb Tide - March 30, 2017

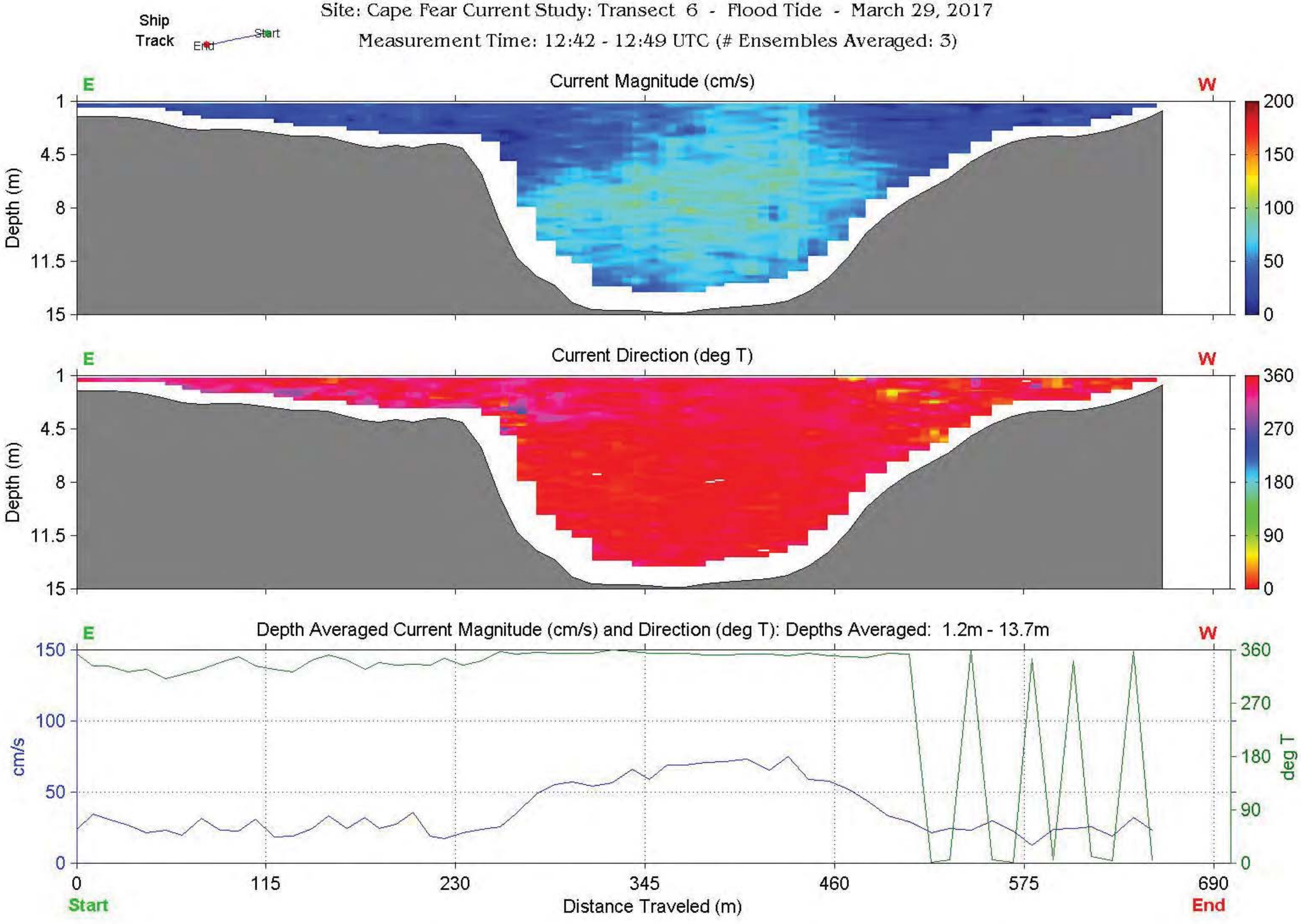
Measurement Time: 22:06 - 22:07 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 29, 2017

Measurement Time: 11:59 - 12:04 UTC (# Ensembles Averaged: 3)

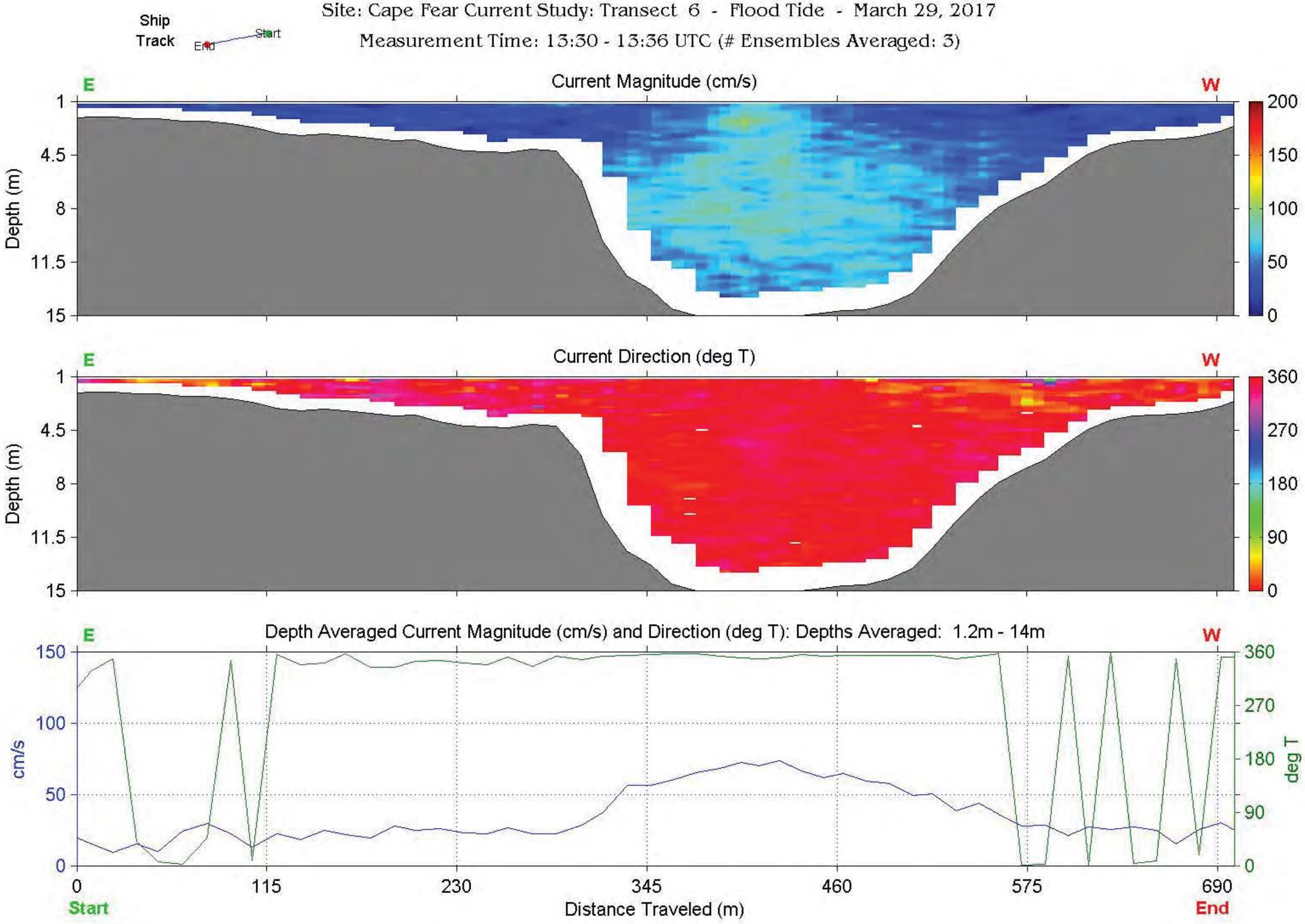


Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 29, 2017

Measurement Time: 12:42 - 12:49 UTC (# Ensembles Averaged: 3)

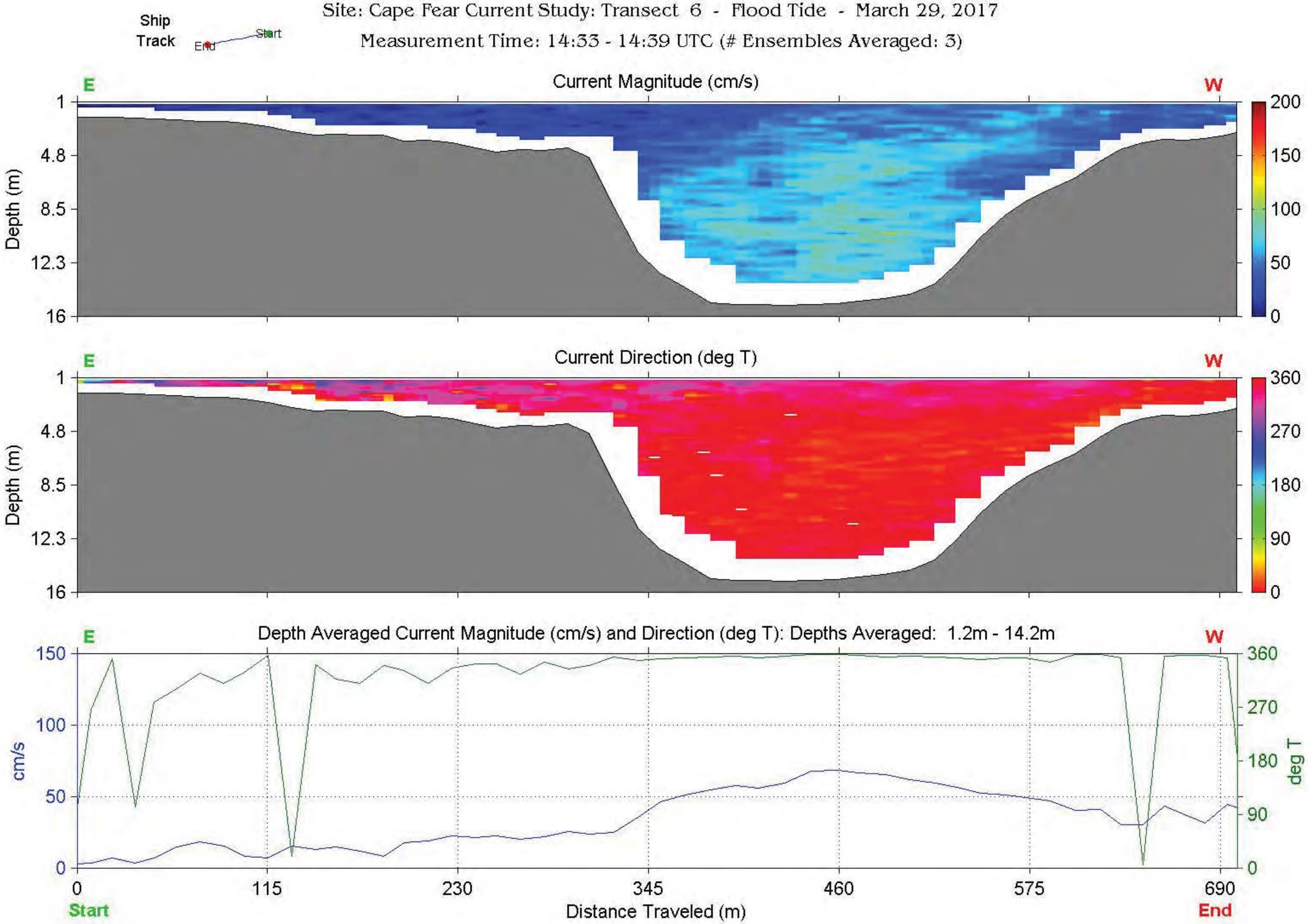
Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 29, 2017

Measurement Time: 13:30 - 13:36 UTC (# Ensembles Averaged: 3)



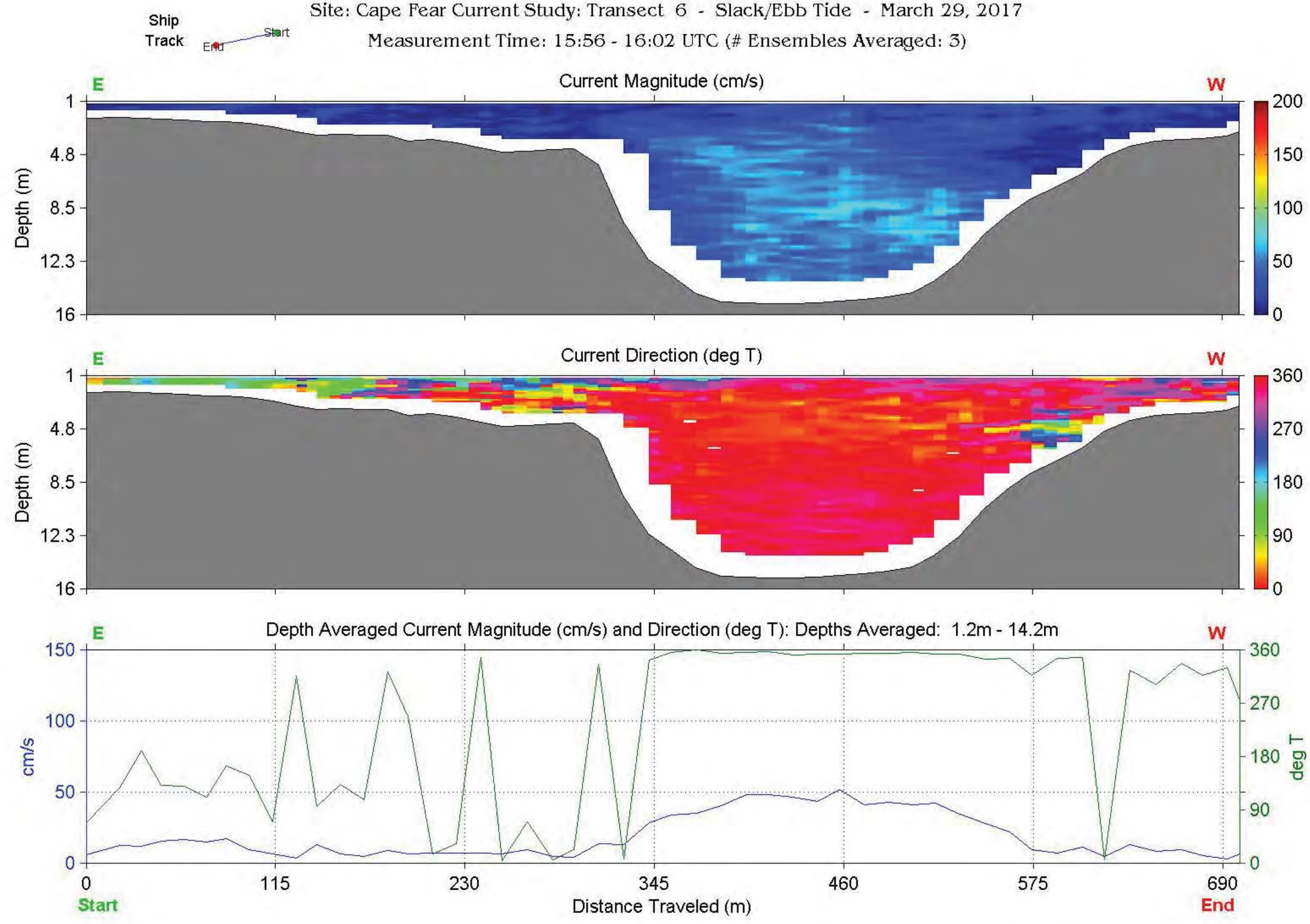
Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 29, 2017

Measurement Time: 14:33 - 14:39 UTC (# Ensembles Averaged: 3)



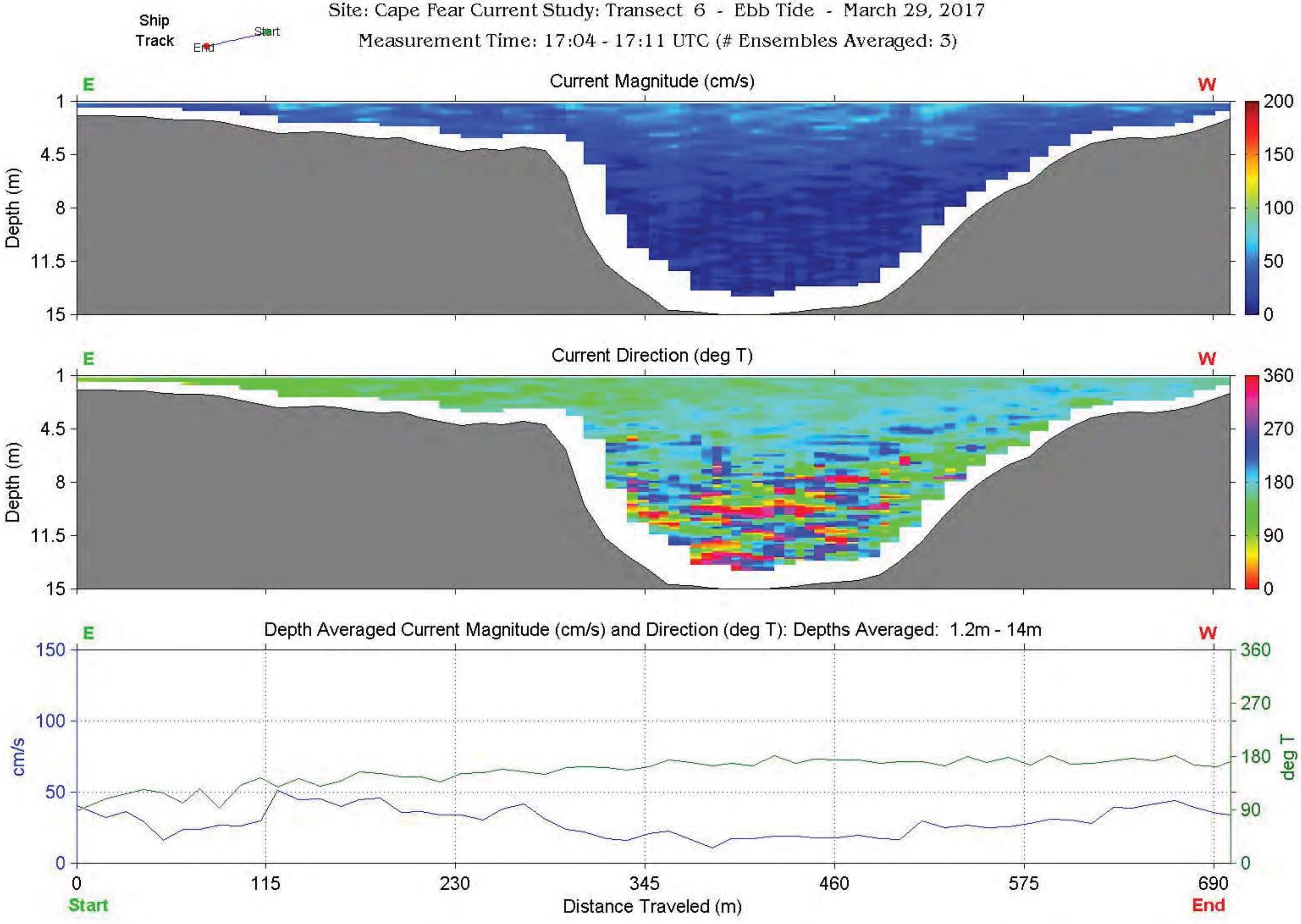
Site: Cape Fear Current Study: Transect 6 - Slack/Ebb Tide - March 29, 2017

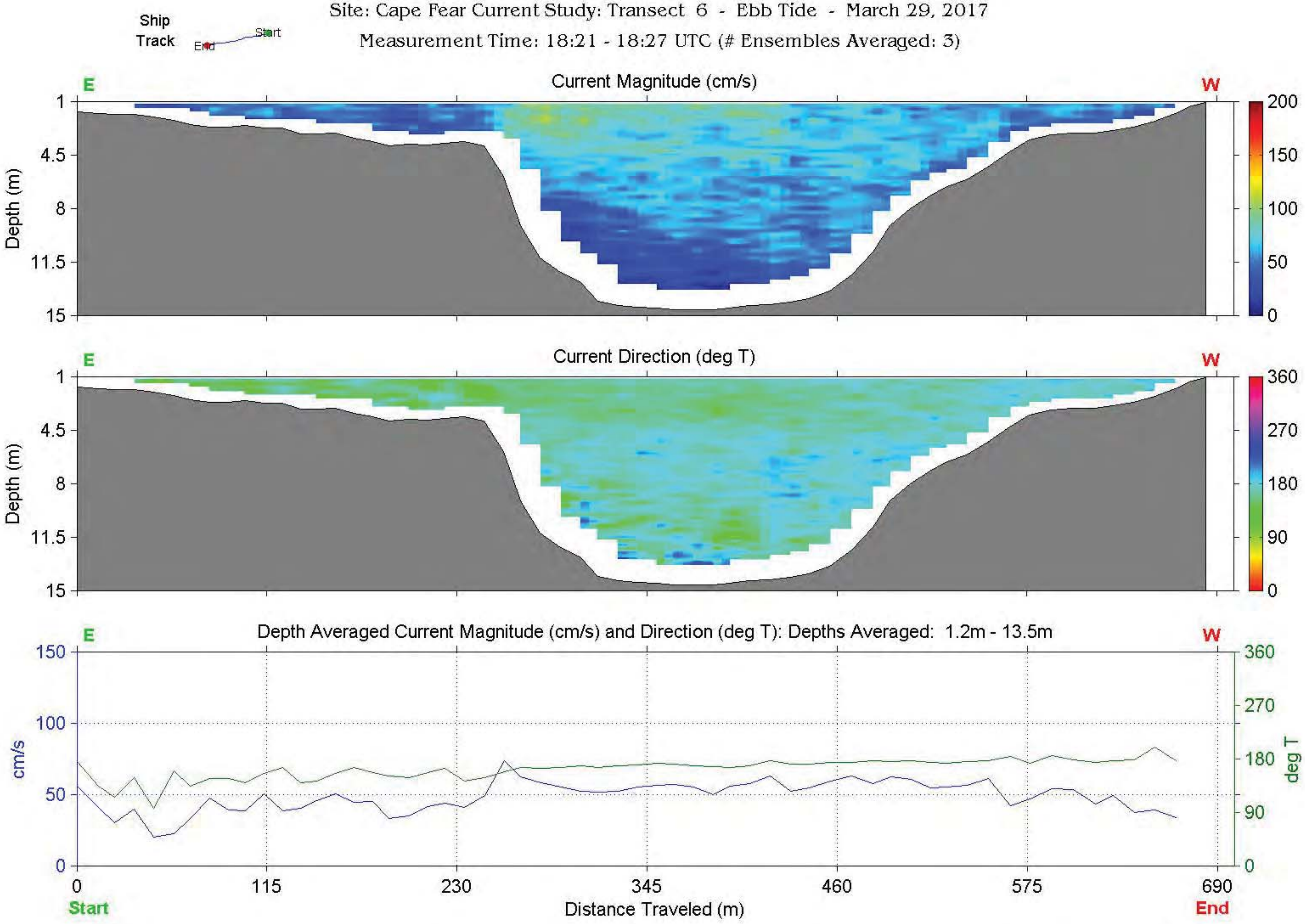
Measurement Time: 15:56 - 16:02 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 29, 2017

Measurement Time: 17:04 - 17:11 UTC (# Ensembles Averaged: 3)



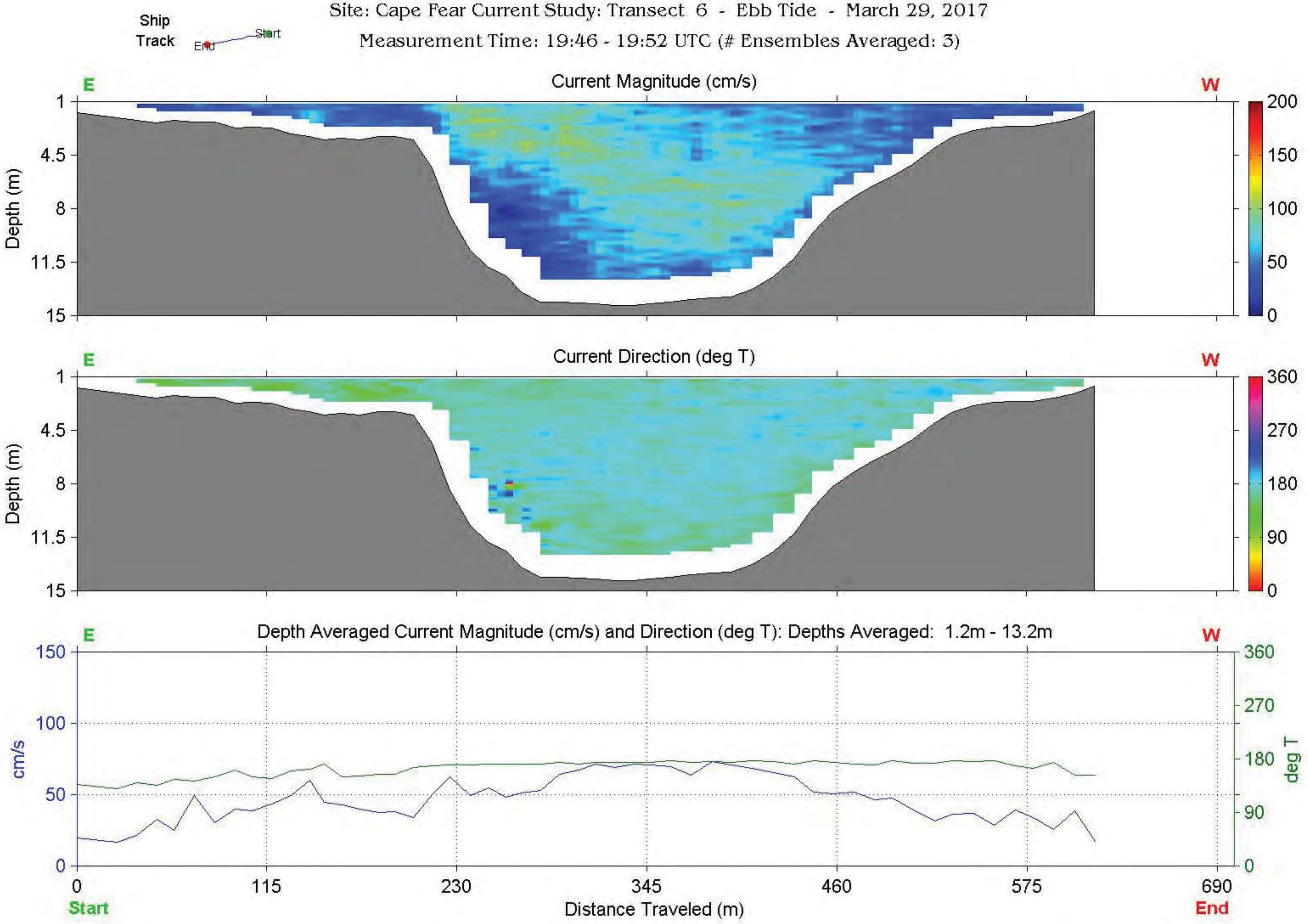


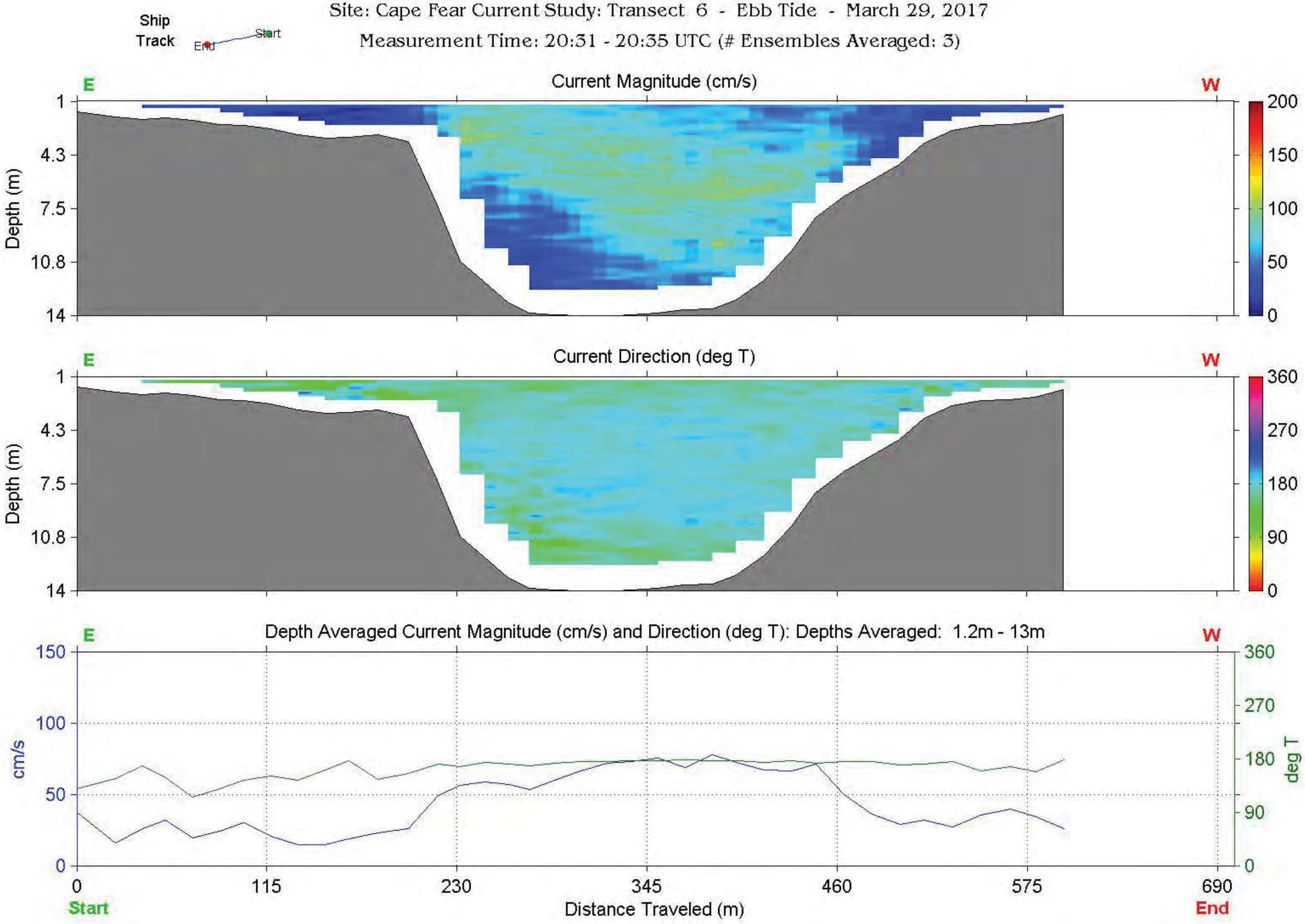
Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 29, 2017

Measurement Time: 18:21 - 18:27 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 29, 2017

Measurement Time: 19:46 - 19:52 UTC (# Ensembles Averaged: 3)



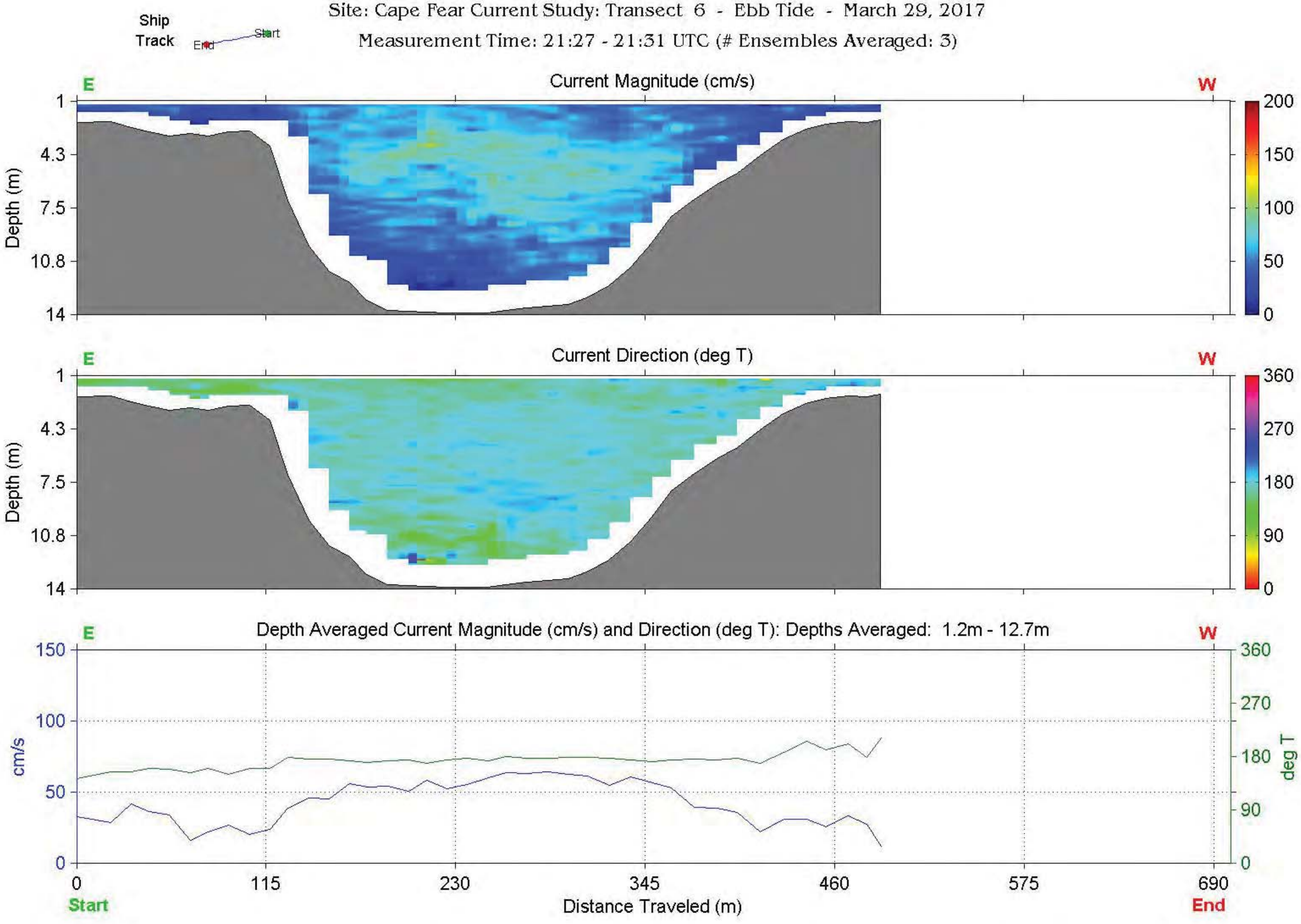


Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 29, 2017

Measurement Time: 20:31 - 20:35 UTC (# Ensembles Averaged: 3)

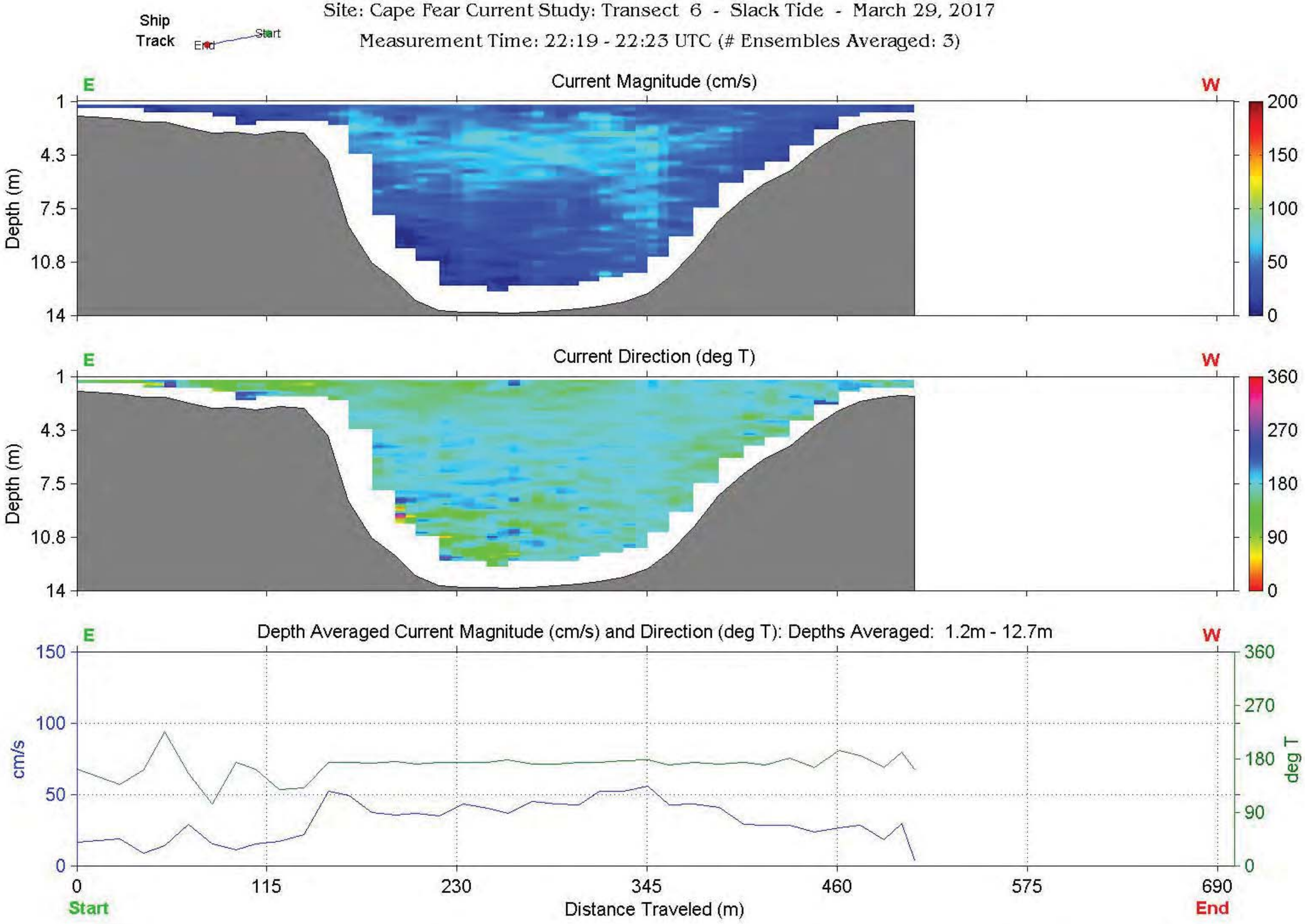
Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 29, 2017

Measurement Time: 21:27 - 21:31 UTC (# Ensembles Averaged: 3)



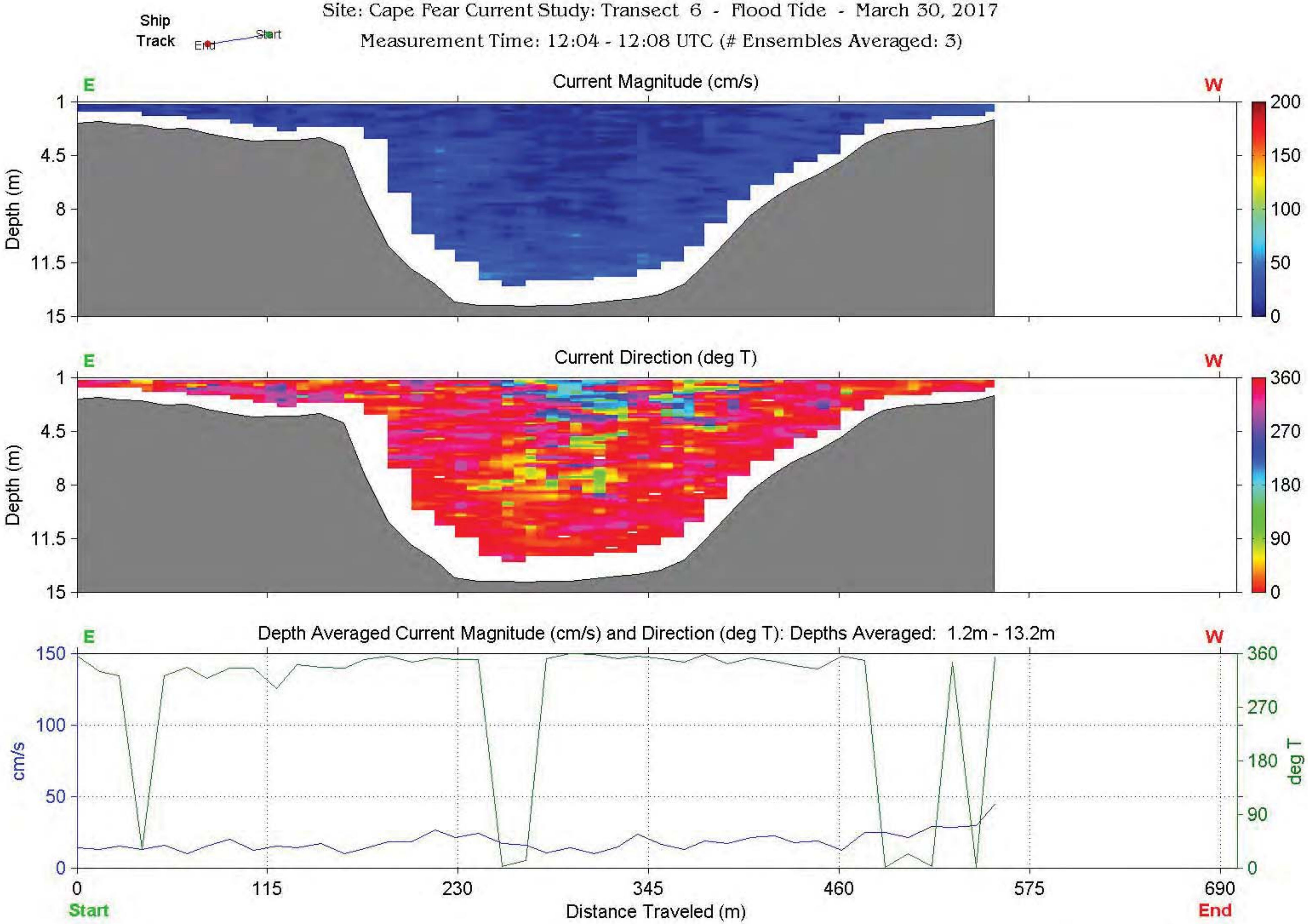
Site: Cape Fear Current Study: Transect 6 - Slack Tide - March 29, 2017

Measurement Time: 22:19 - 22:23 UTC (# Ensembles Averaged: 3)



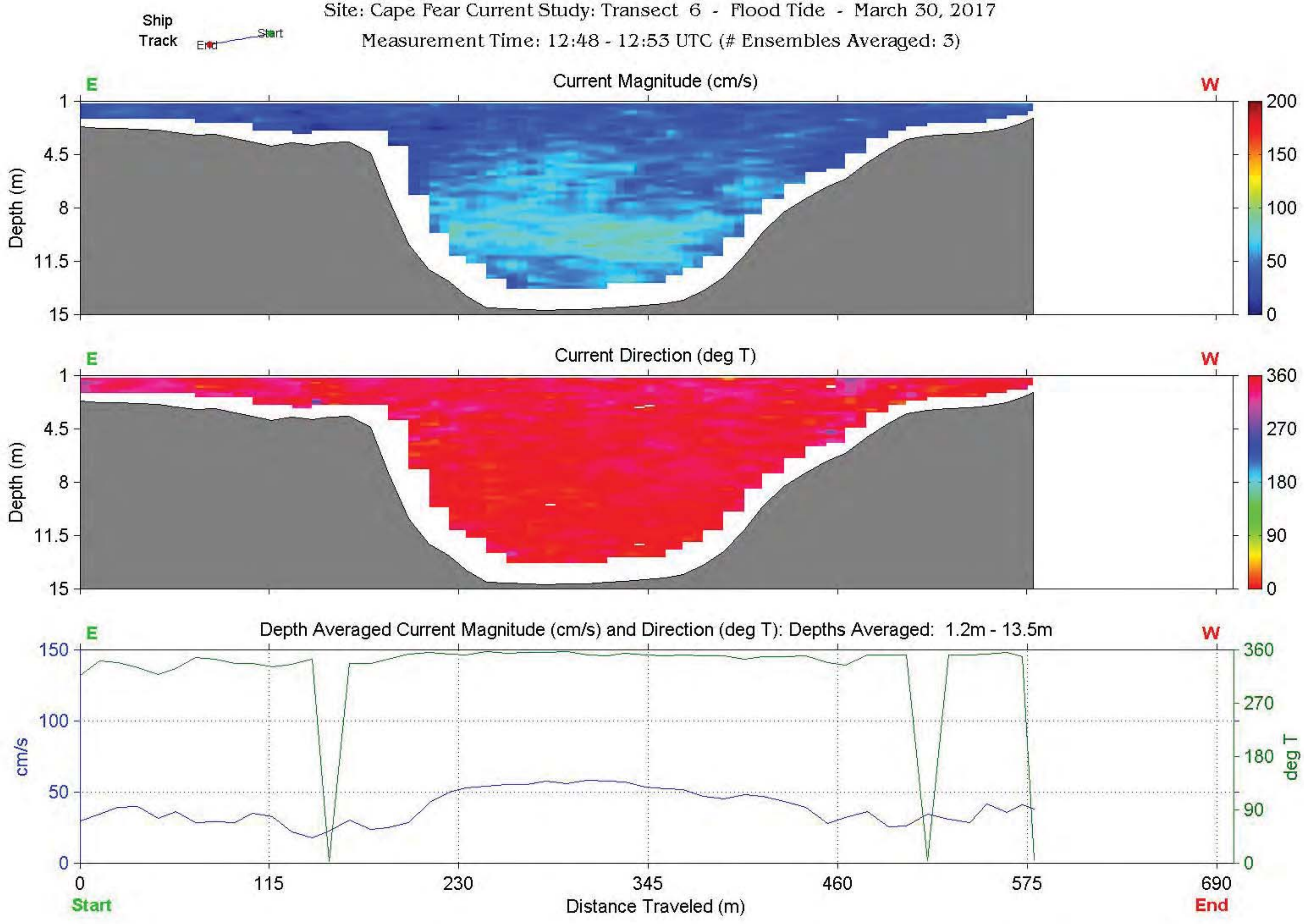
Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 30, 2017

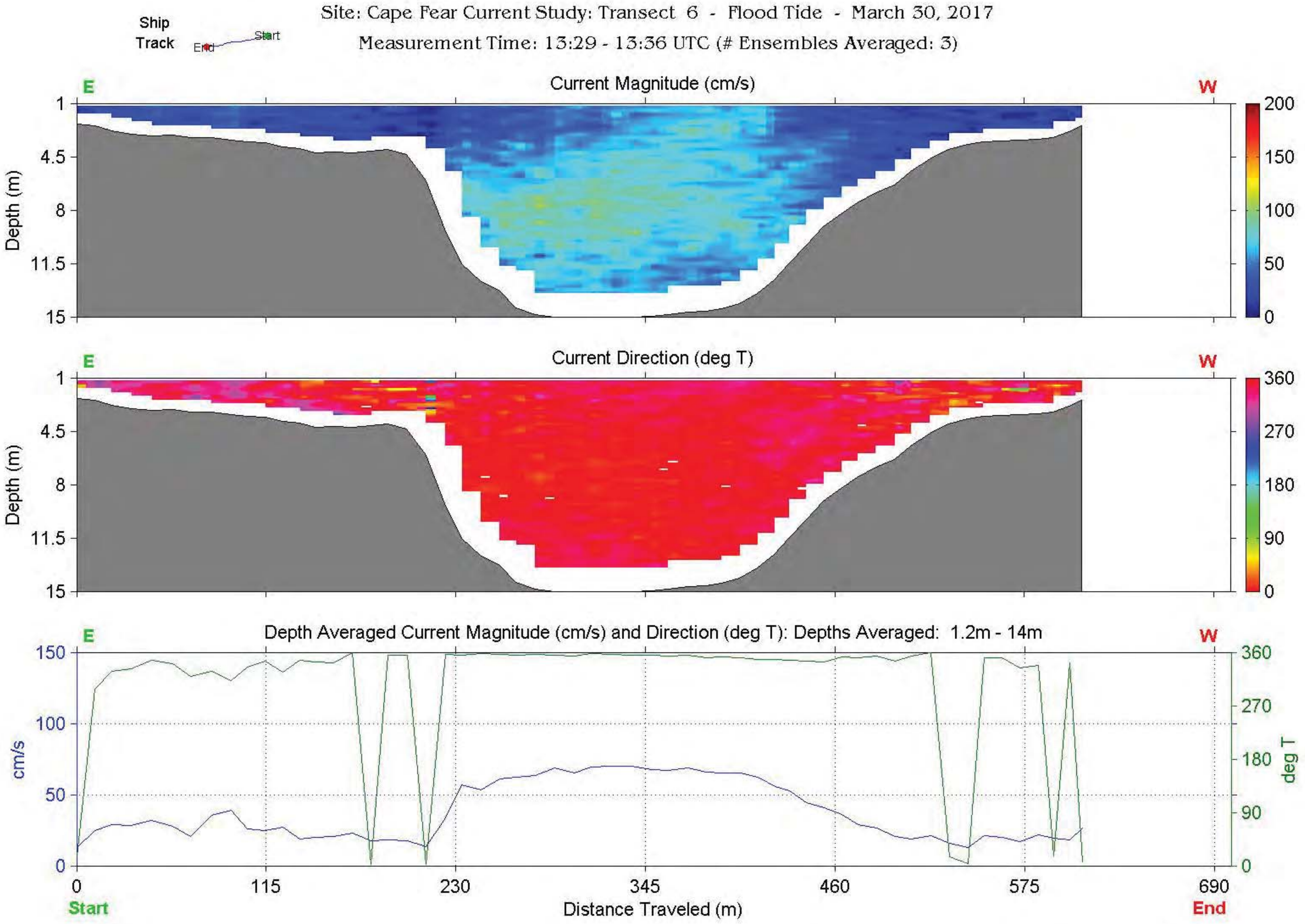
Measurement Time: 12:04 - 12:08 UTC (# Ensembles Averaged: 3)



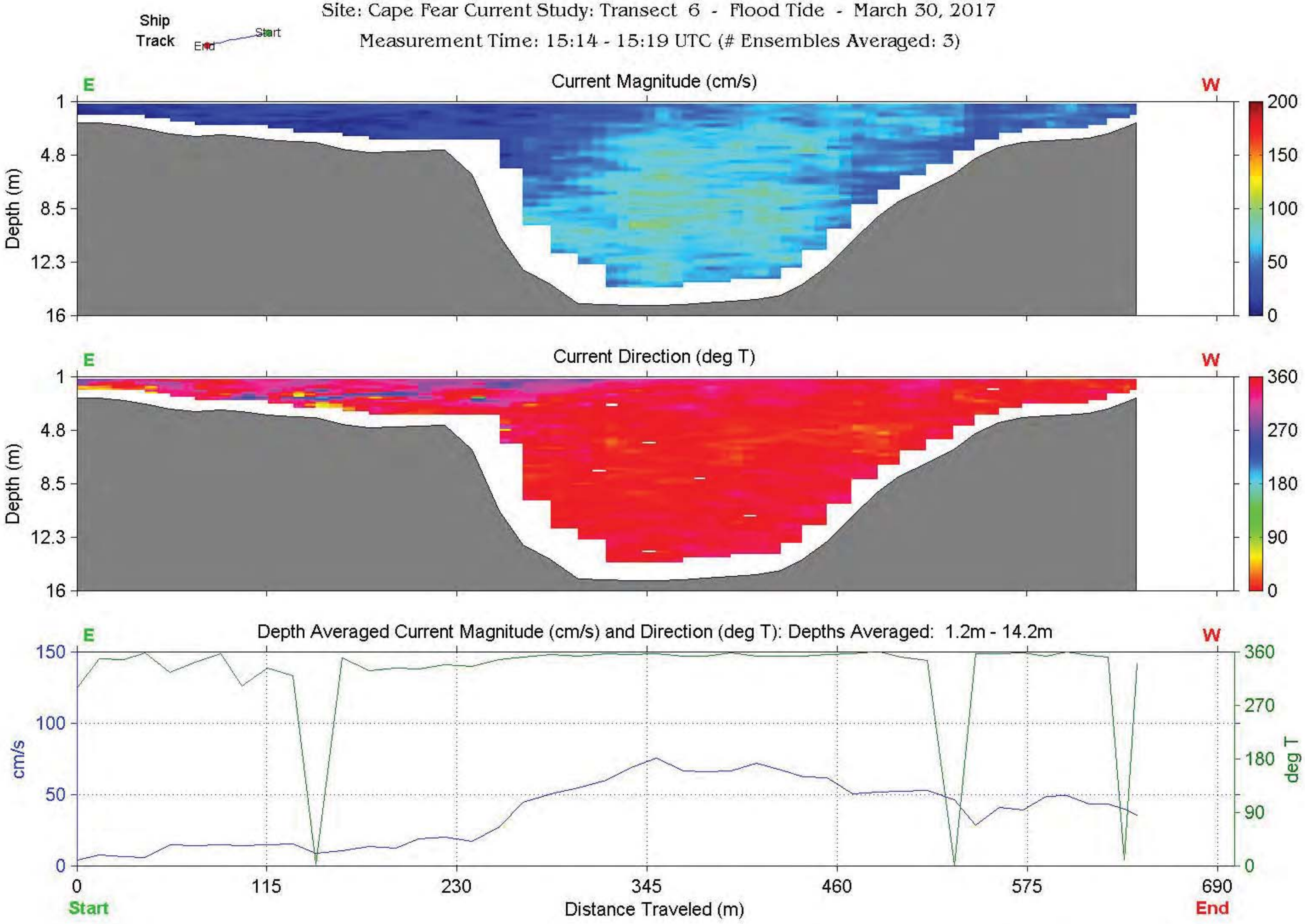
Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 30, 2017

Measurement Time: 12:48 - 12:53 UTC (# Ensembles Averaged: 3)



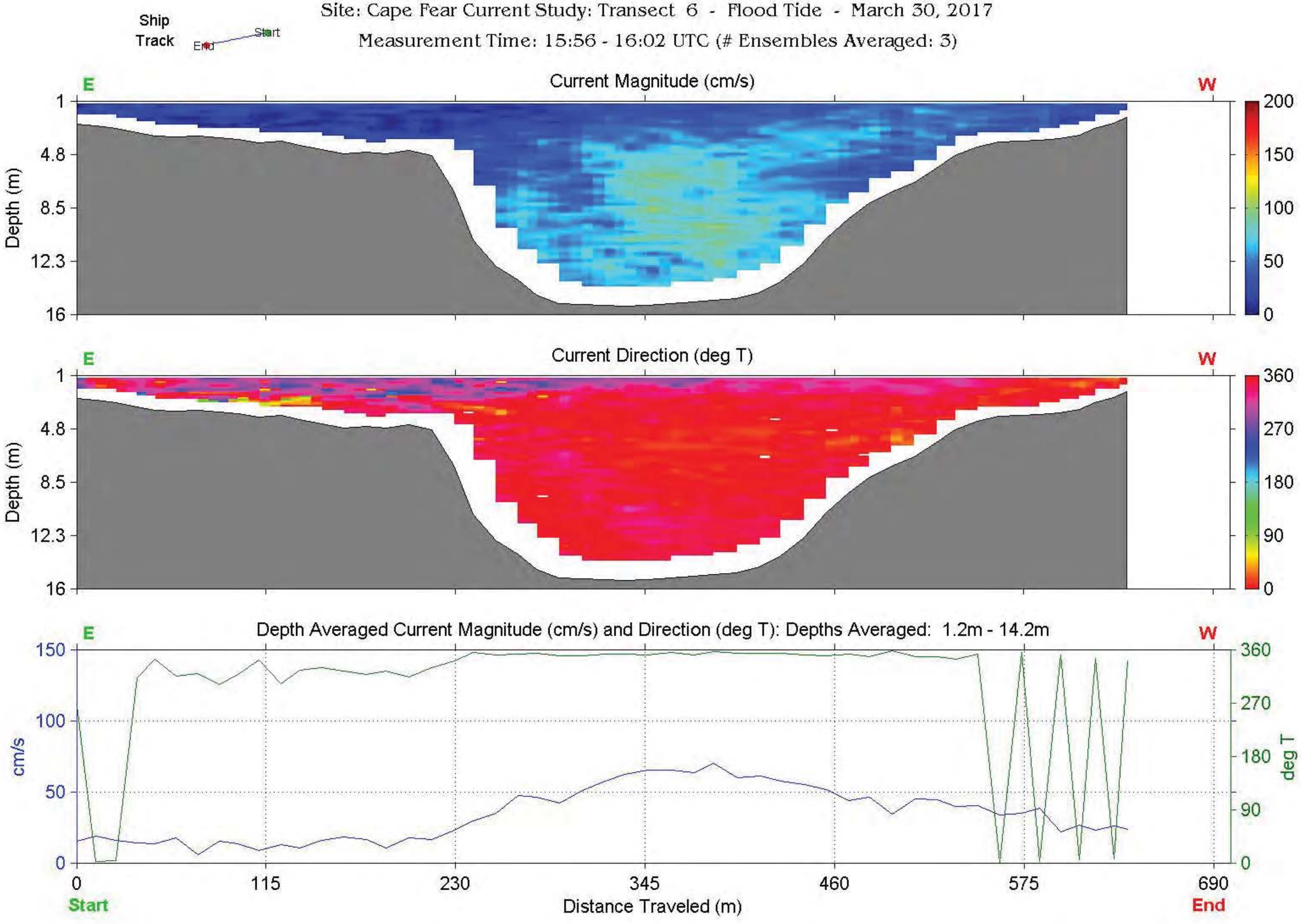

Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 30, 2017

Measurement Time: 13:29 - 13:36 UTC (# Ensembles Averaged: 3)



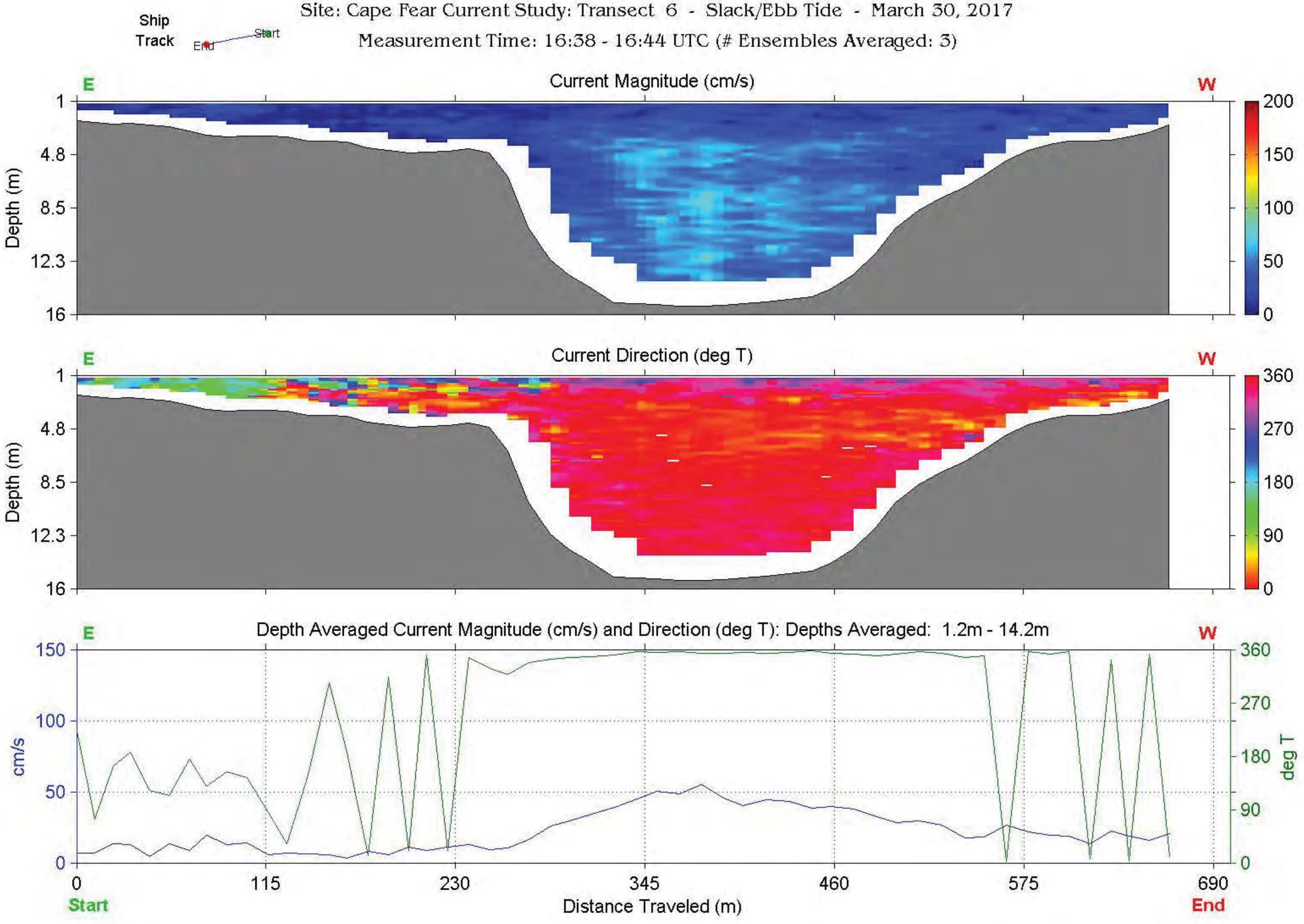
Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 30, 2017

Measurement Time: 15:14 - 15:19 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 6 - Flood Tide - March 30, 2017

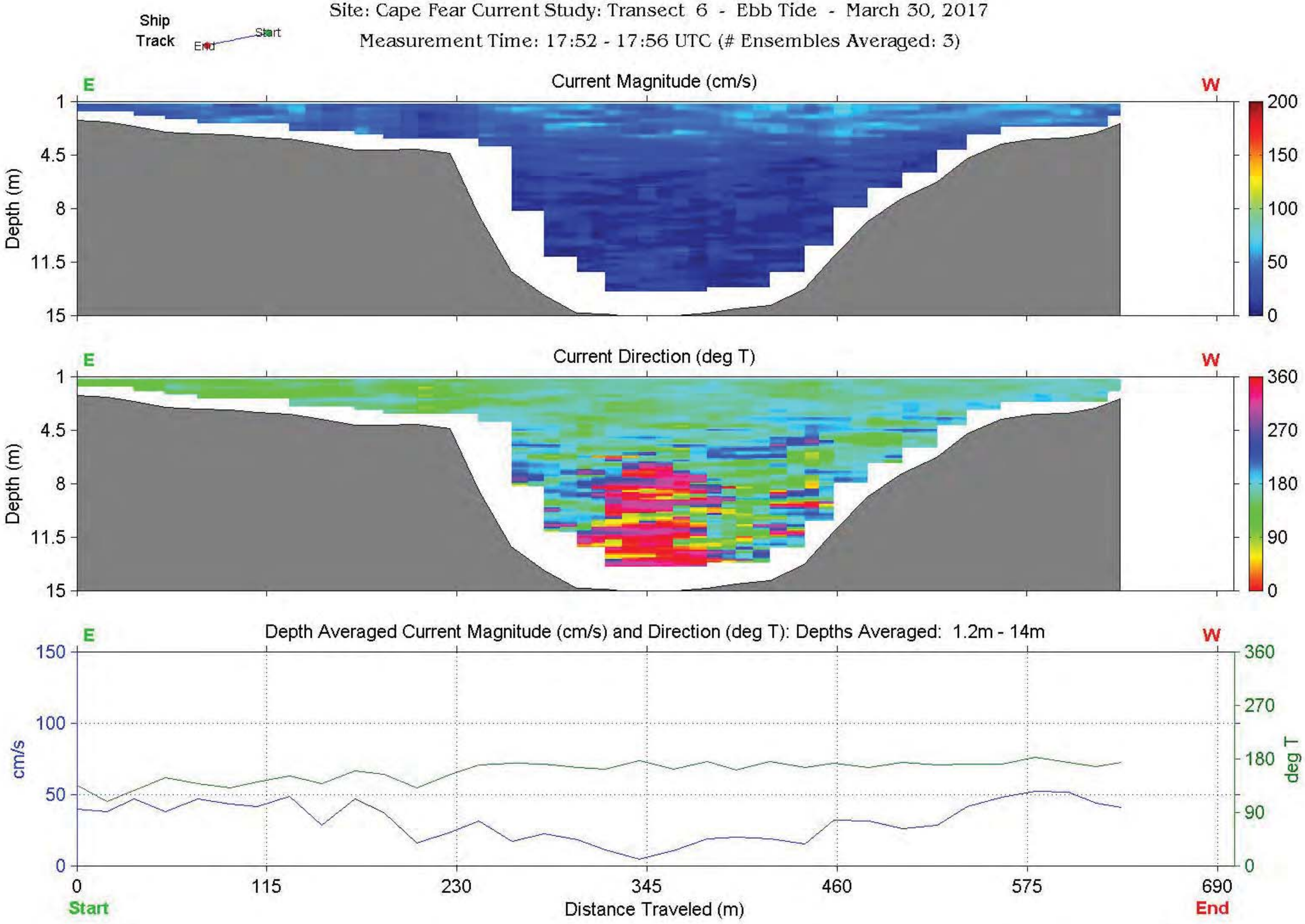
Measurement Time: 15:56 - 16:02 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 6 - Slack/Ebb Tide - March 30, 2017

Measurement Time: 16:38 - 16:44 UTC (# Ensembles Averaged: 3)

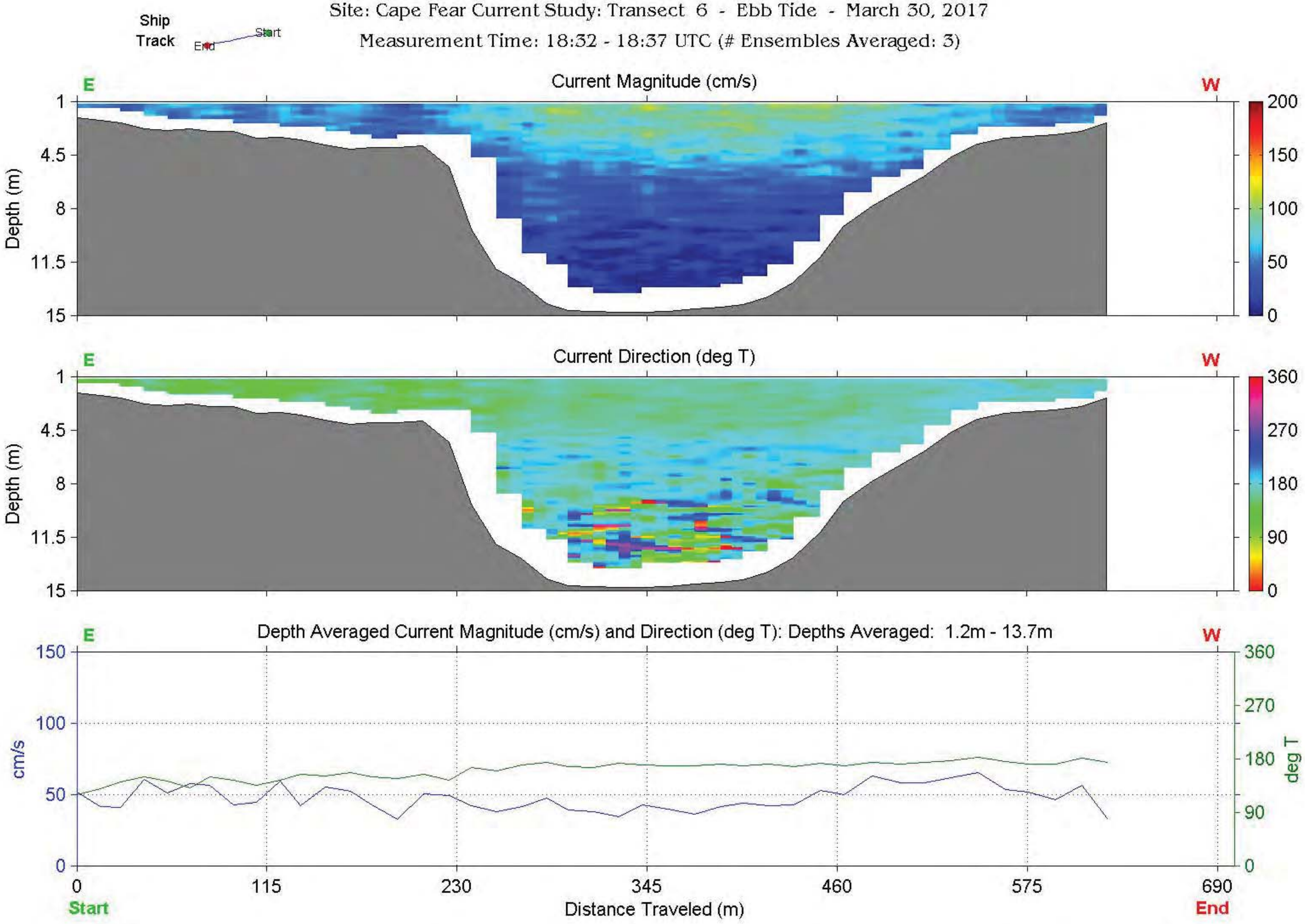
Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 30, 2017

Measurement Time: 17:52 - 17:56 UTC (# Ensembles Averaged: 3)



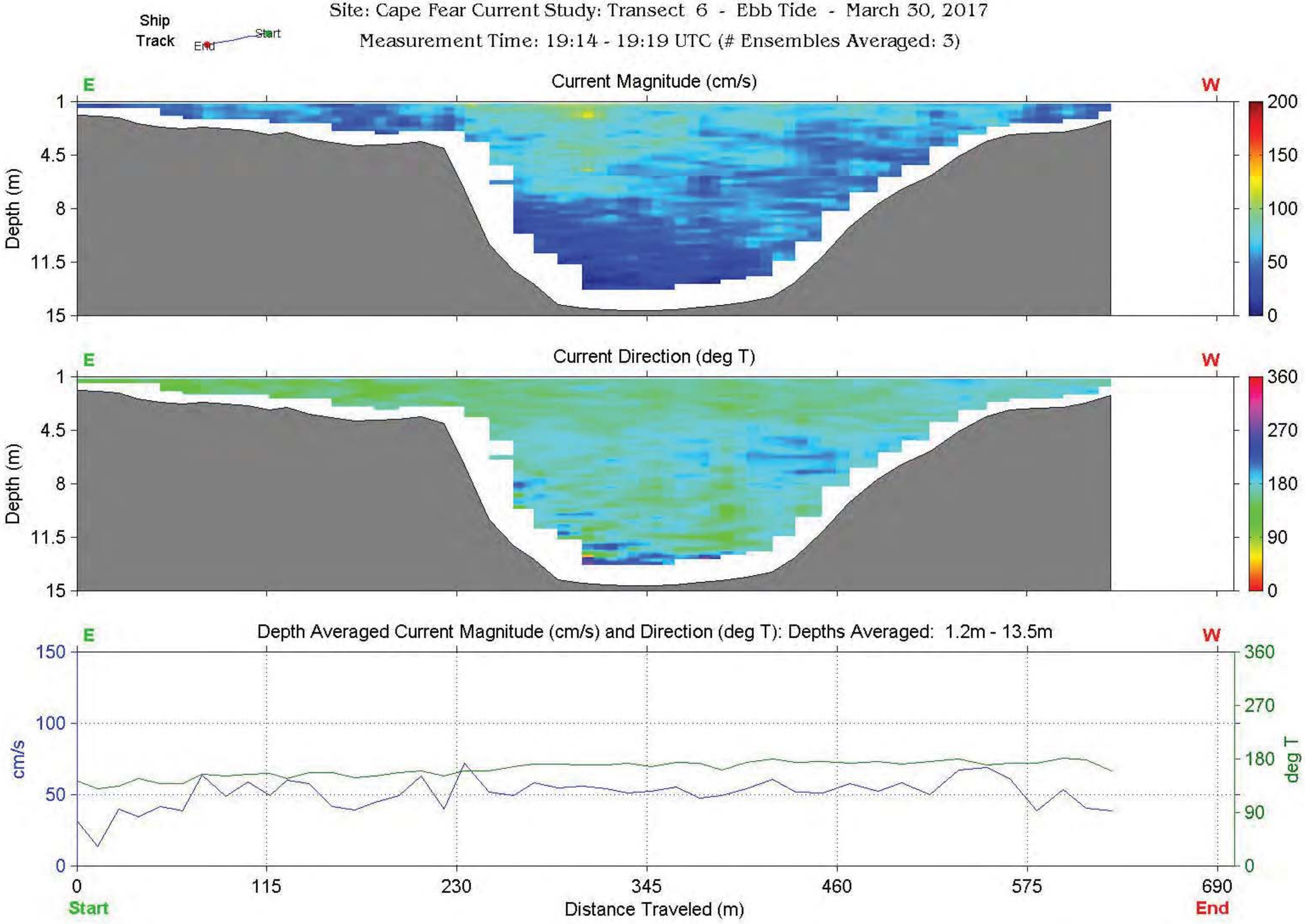
Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 30, 2017

Measurement Time: 18:32 - 18:37 UTC (# Ensembles Averaged: 3)



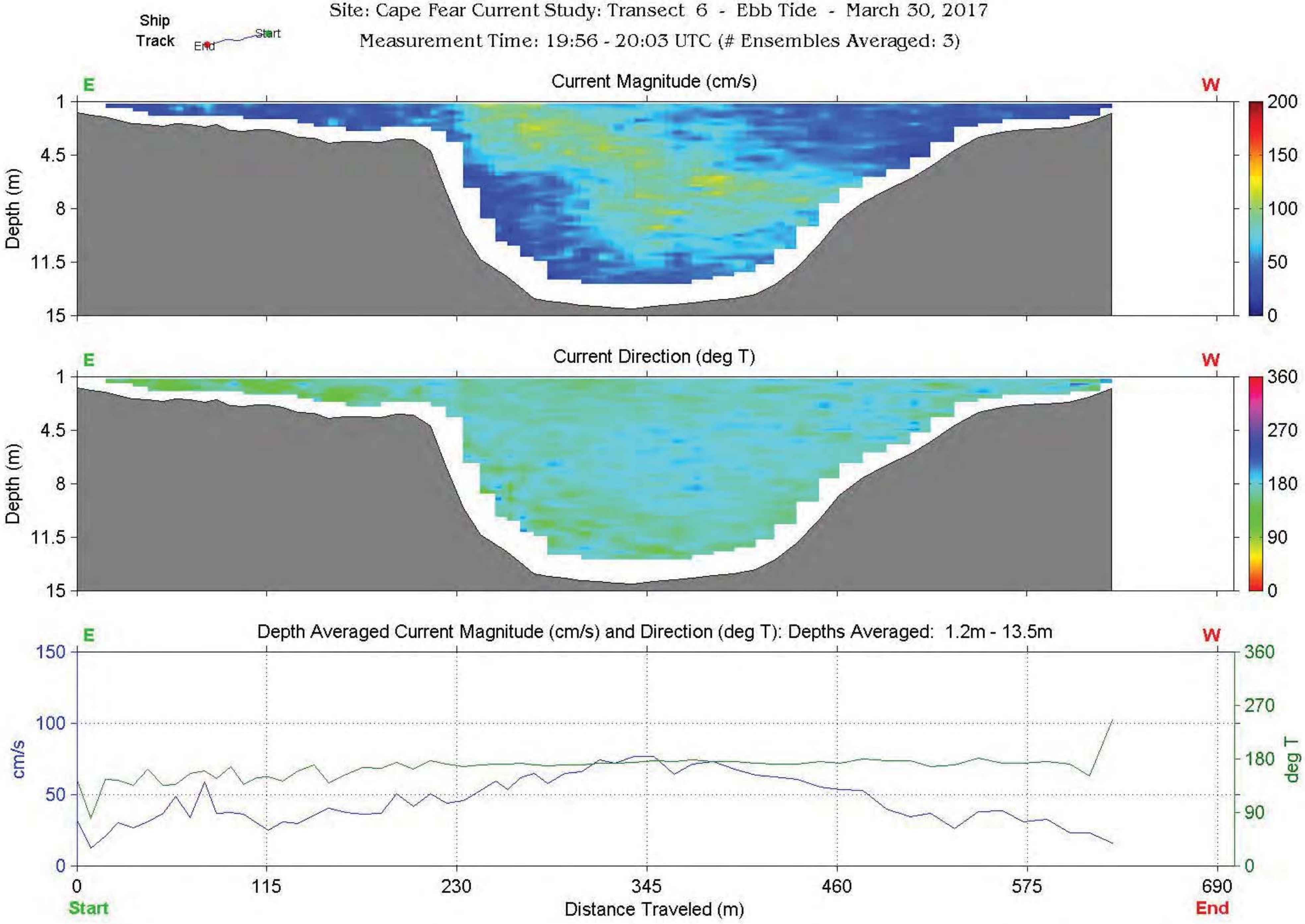
Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 30, 2017

Measurement Time: 19:14 - 19:19 UTC (# Ensembles Averaged: 3)



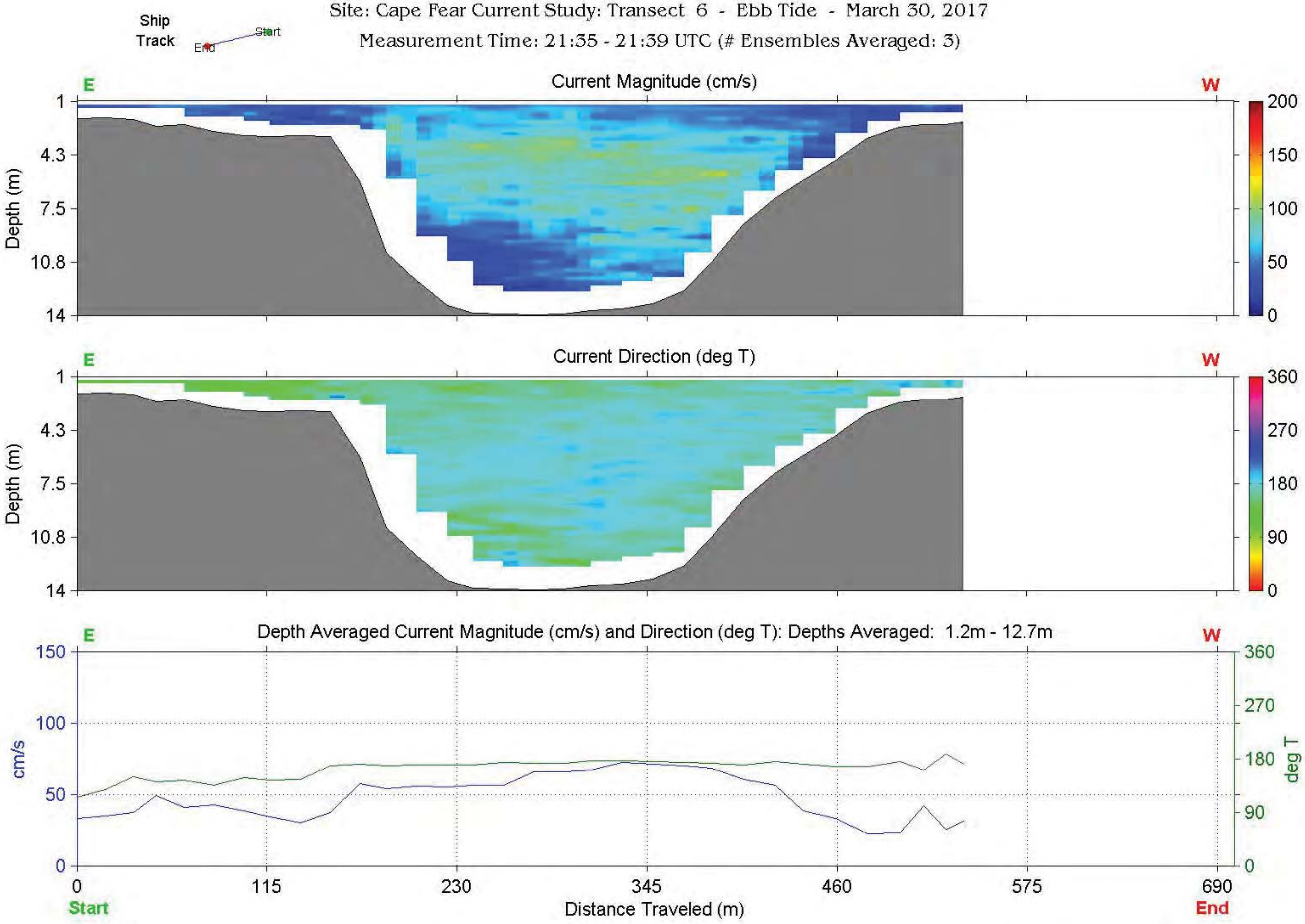
Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 30, 2017

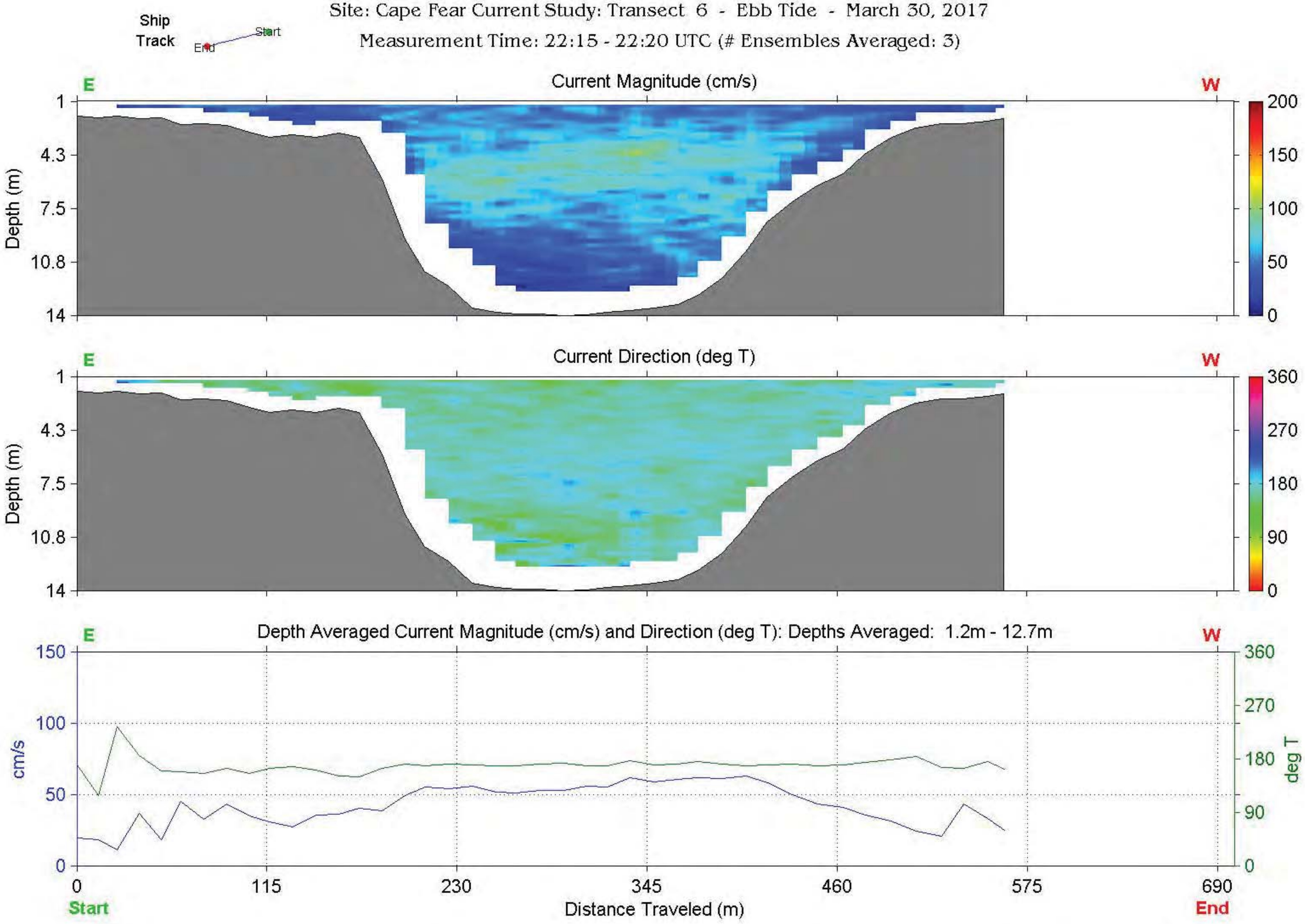
Measurement Time: 19:56 - 20:03 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 30, 2017

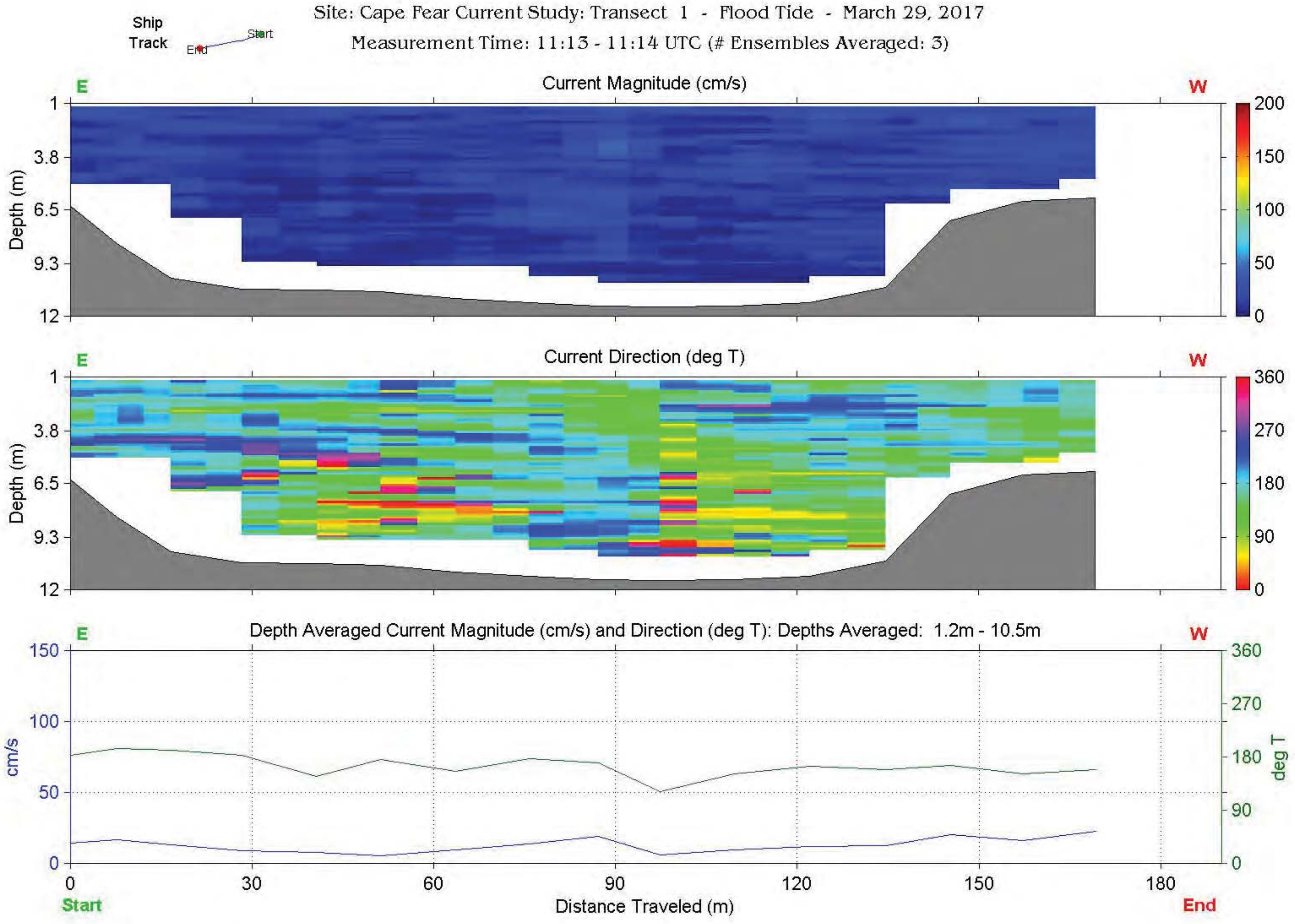
Measurement Time: 21:35 - 21:39 UTC (# Ensembles Averaged: 3)




Site: Cape Fear Current Study: Transect 6 - Ebb Tide - March 30, 2017

Measurement Time: 22:15 - 22:20 UTC (# Ensembles Averaged: 3)

Wilmington
Downtown



Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 29, 2017

Measurement Time: 11:13 - 11:14 UTC (# Ensembles Averaged: 3)

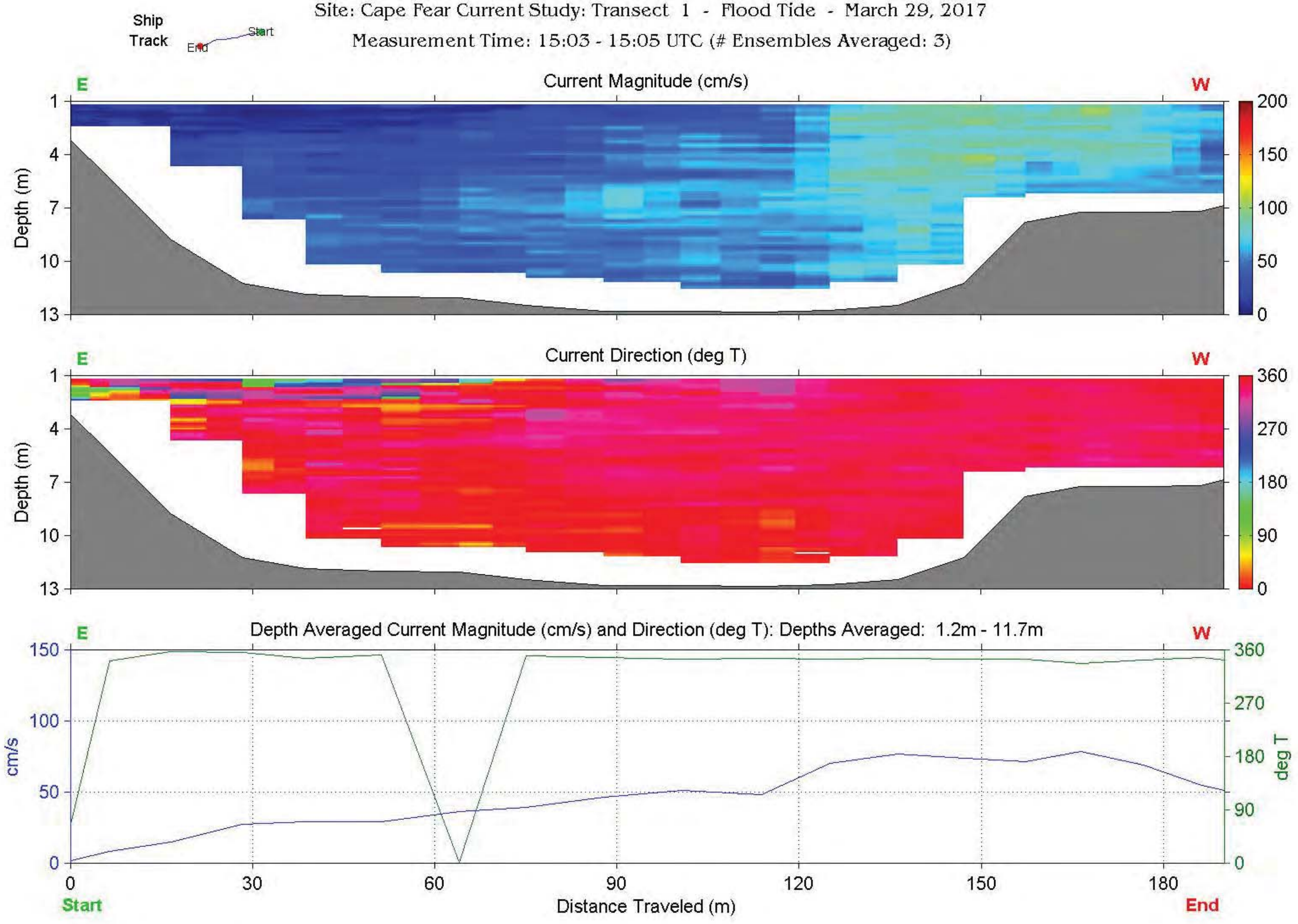
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 10.5m

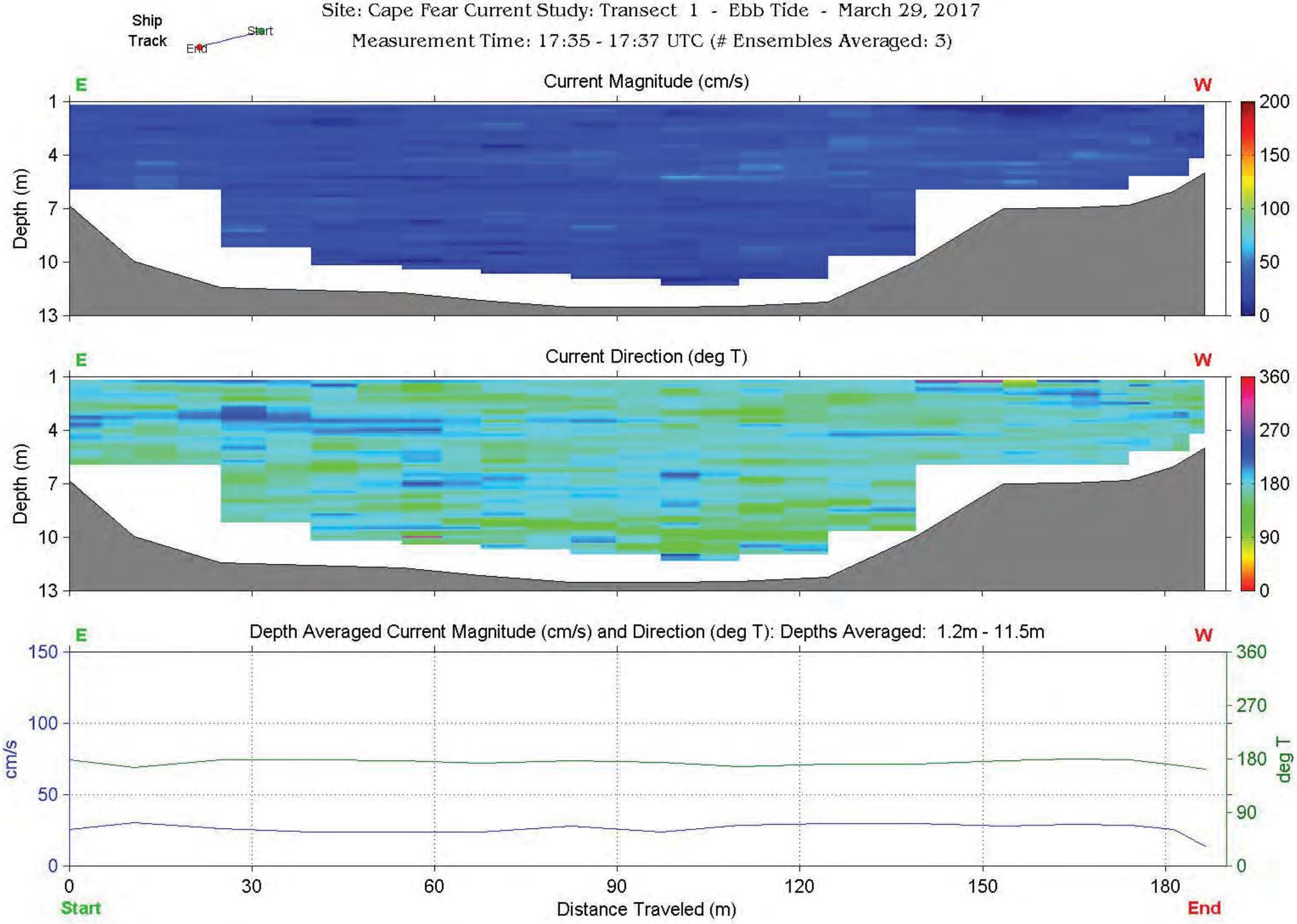
Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 29, 2017

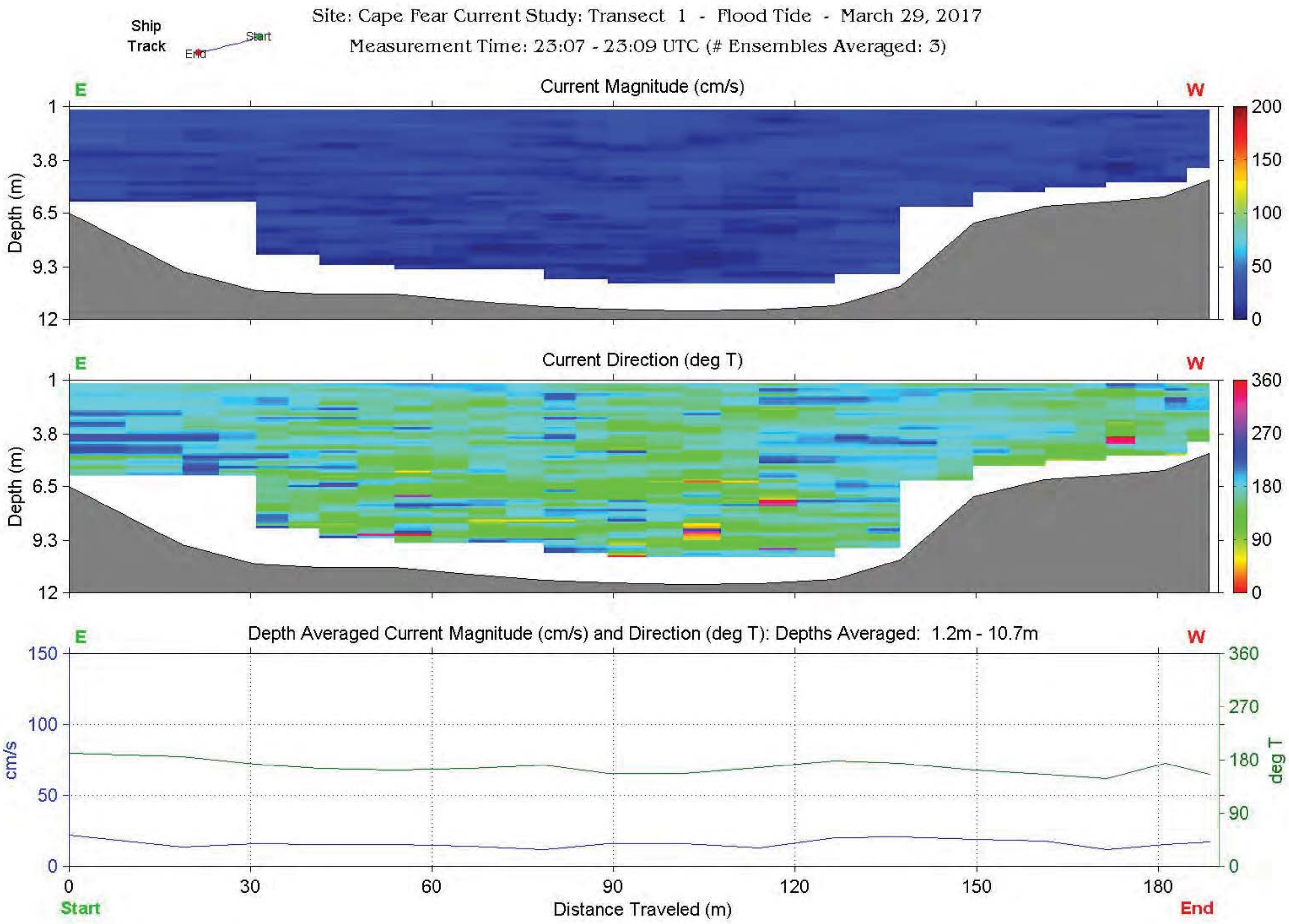
Measurement Time: 15:03 - 15:05 UTC (# Ensembles Averaged: 3)



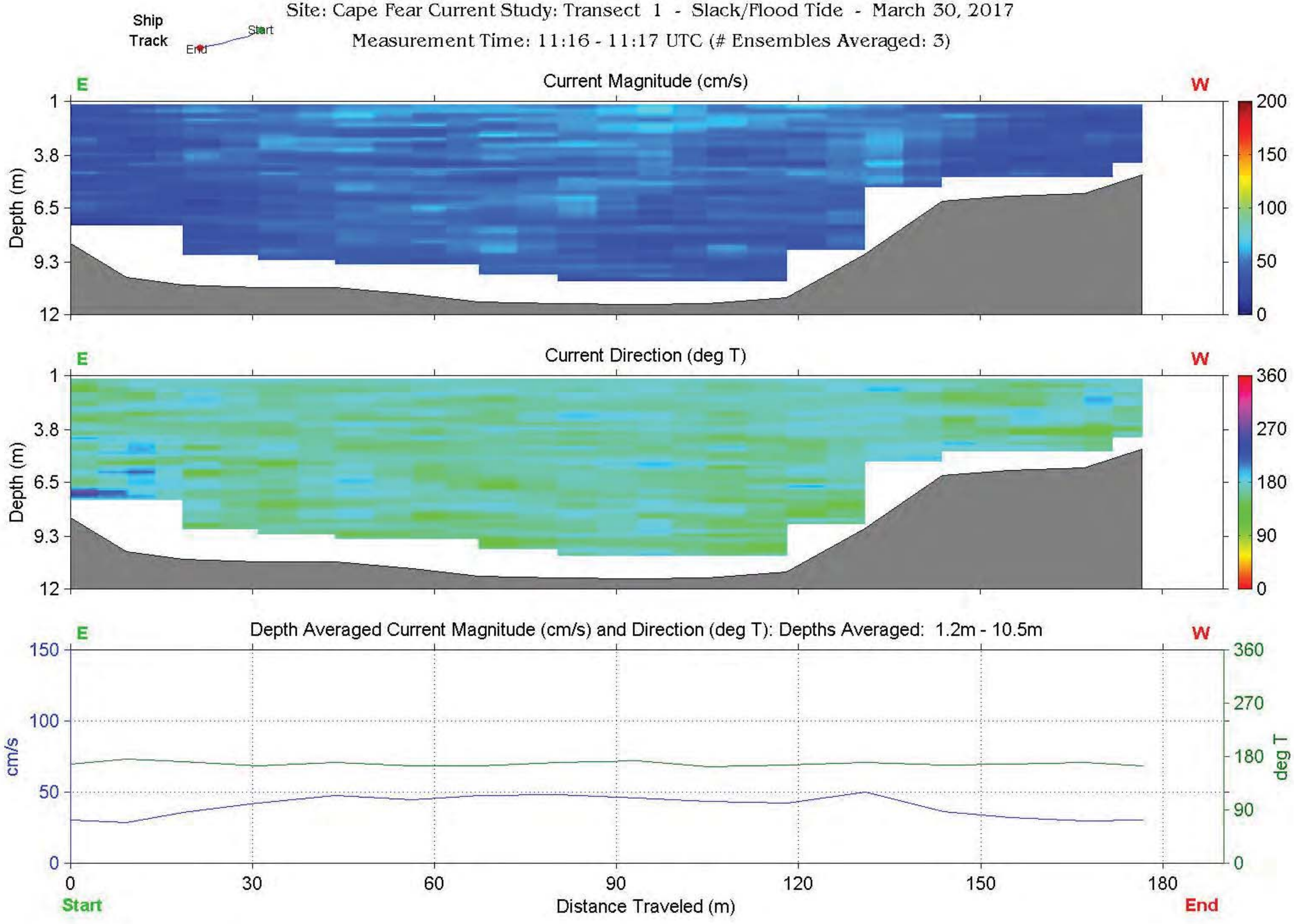
Site: Cape Fear Current Study: Transect 1 - Ebb Tide - March 29, 2017

Measurement Time: 17:35 - 17:37 UTC (# Ensembles Averaged: 3)

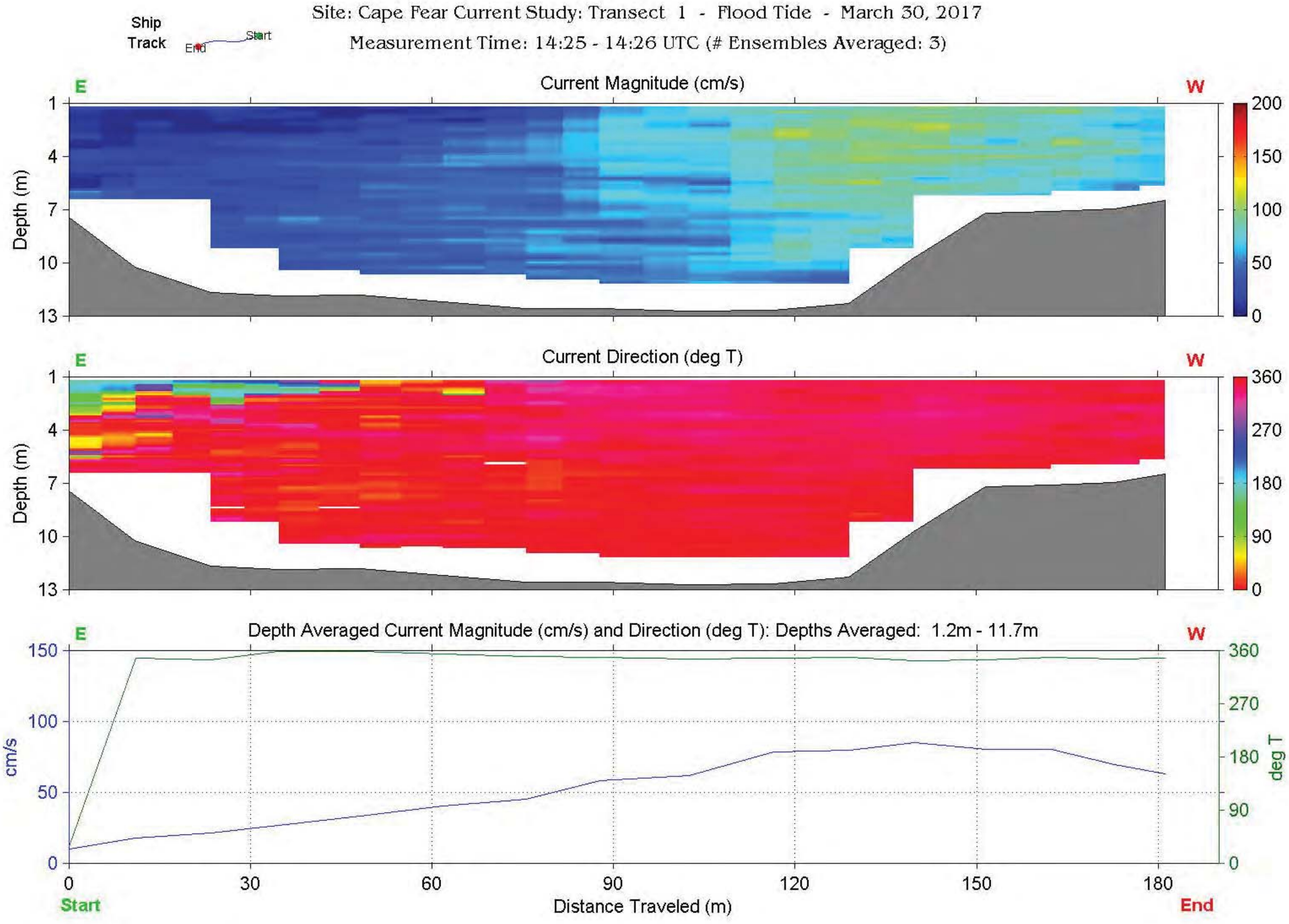



Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 29, 2017

Measurement Time: 23:07 - 23:09 UTC (# Ensembles Averaged: 3)


Site: Cape Fear Current Study: Transect 1 - Slack/Flood Tide - March 30, 2017

Measurement Time: 11:16 - 11:17 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 30, 2017

Measurement Time: 14:25 - 14:26 UTC (# Ensembles Averaged: 3)

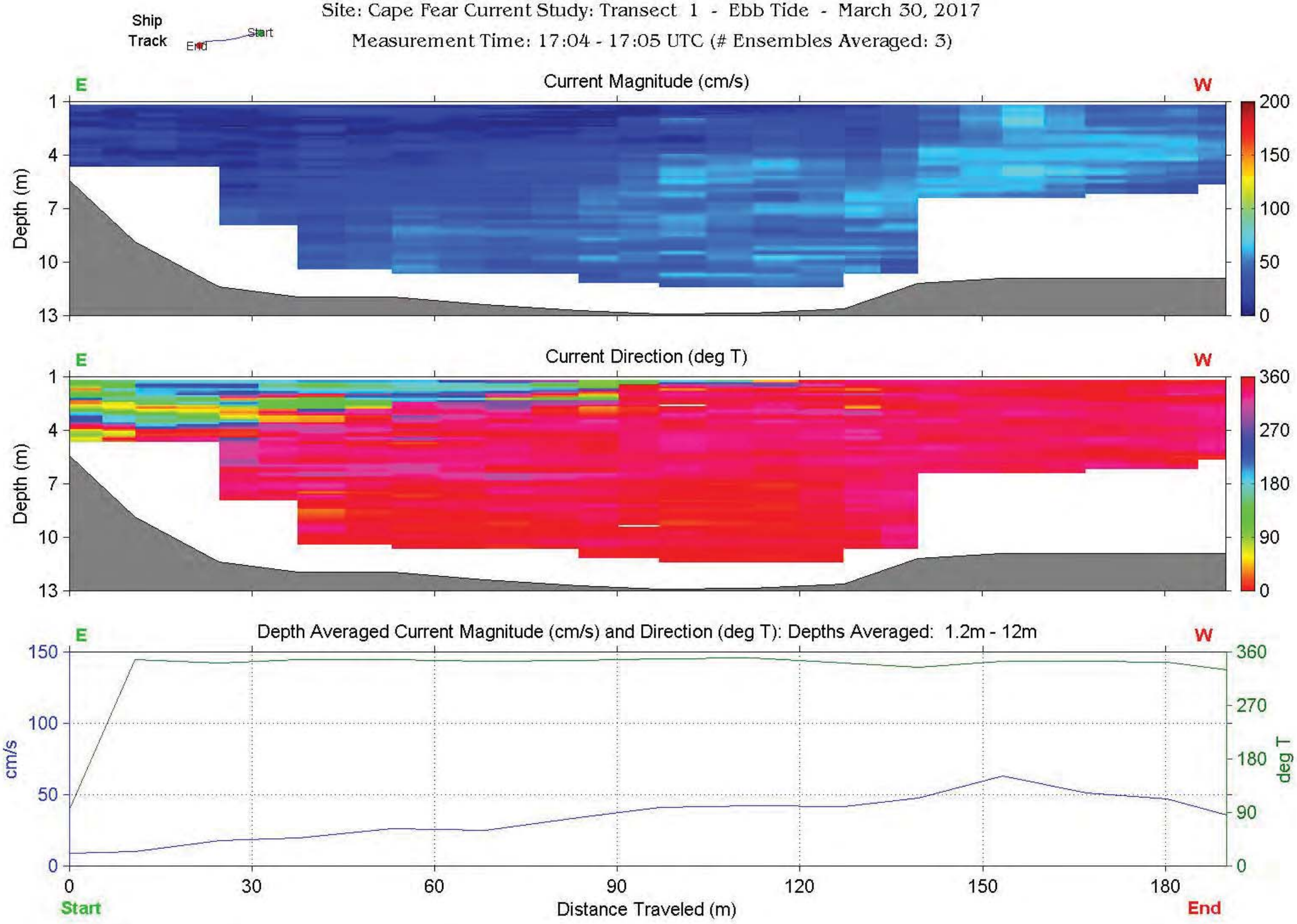
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 11.7m

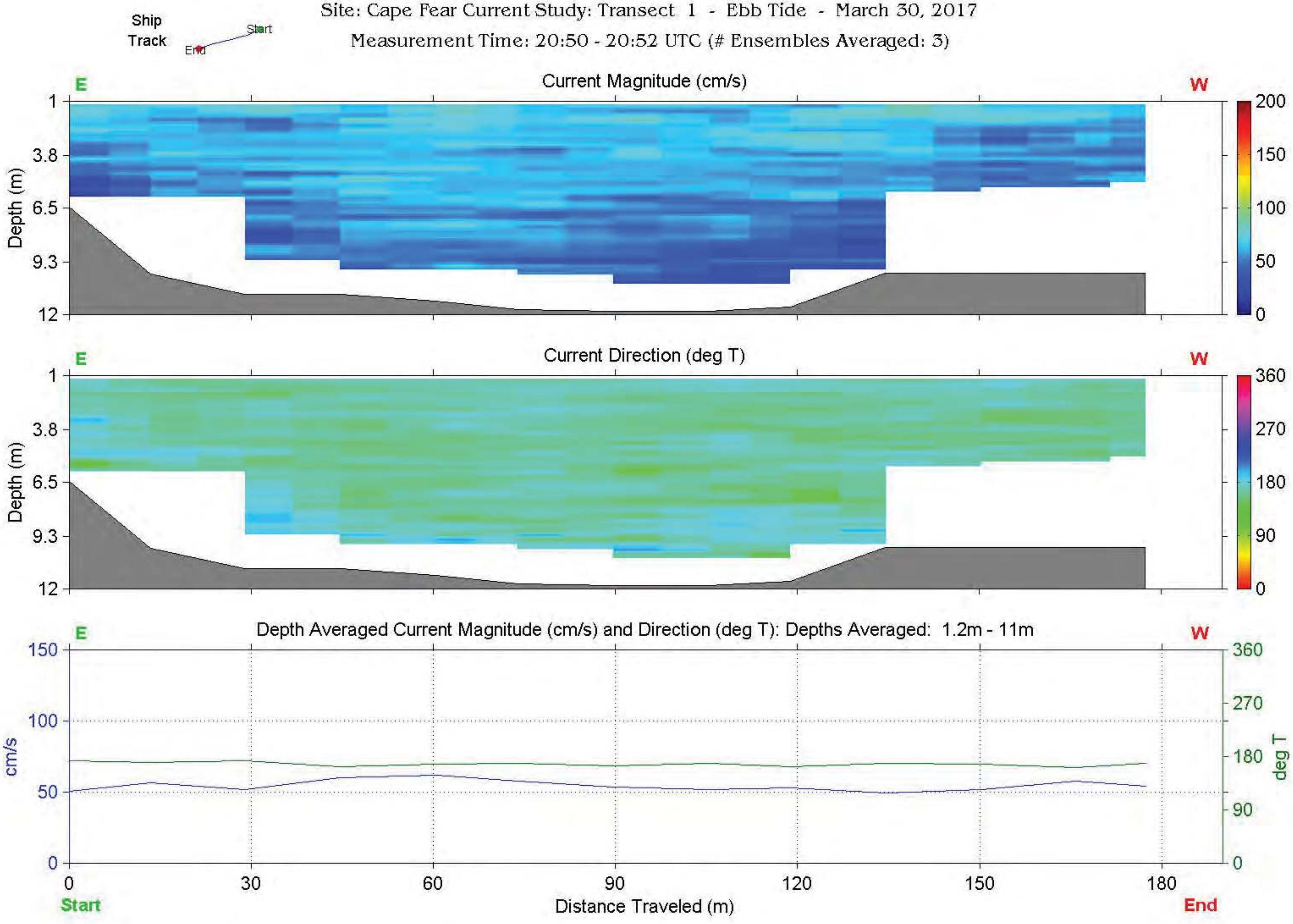
Site: Cape Fear Current Study: Transect 1 - Ebb Tide - March 30, 2017

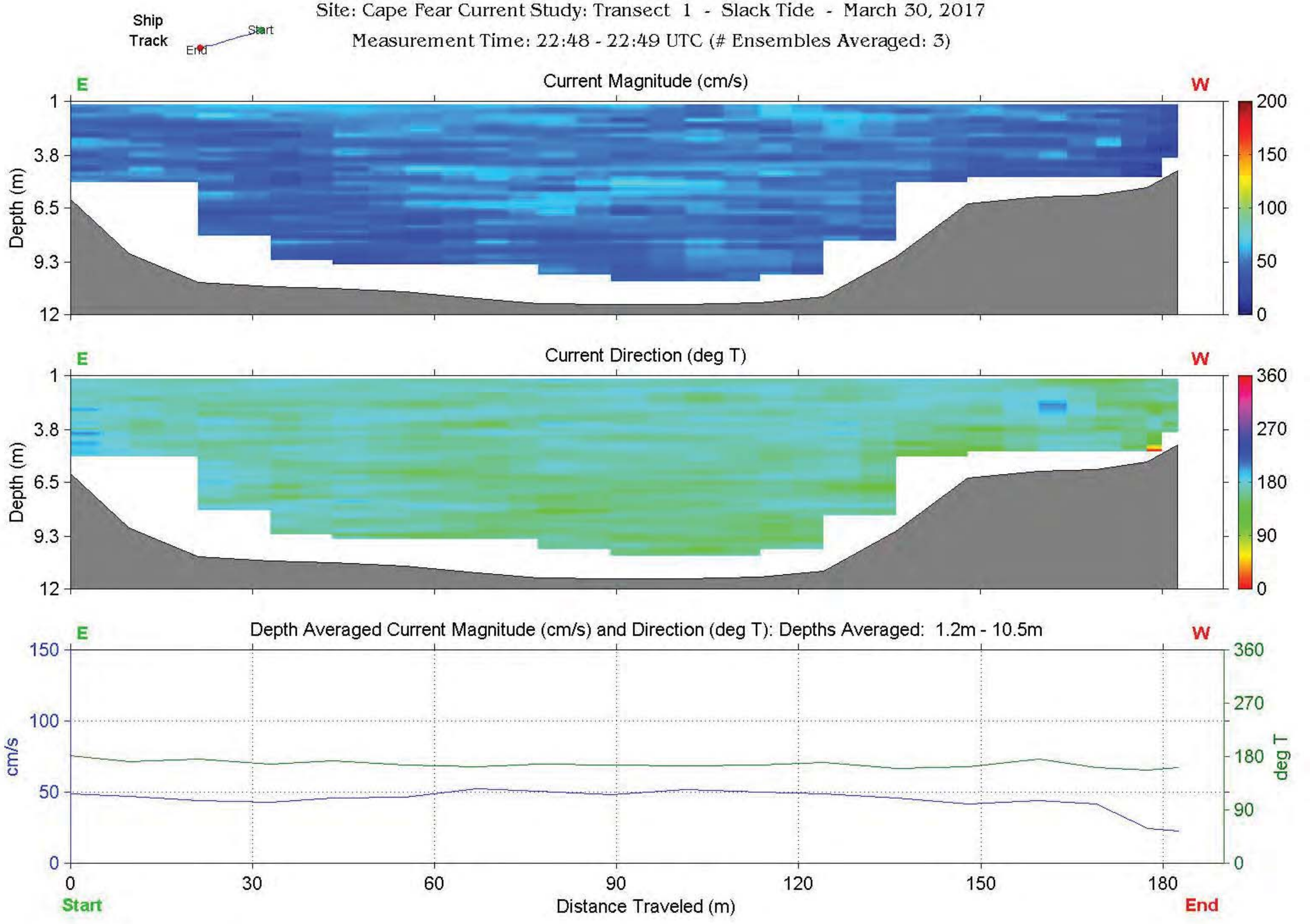
Measurement Time: 17:04 - 17:05 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 1 - Ebb Tide - March 30, 2017

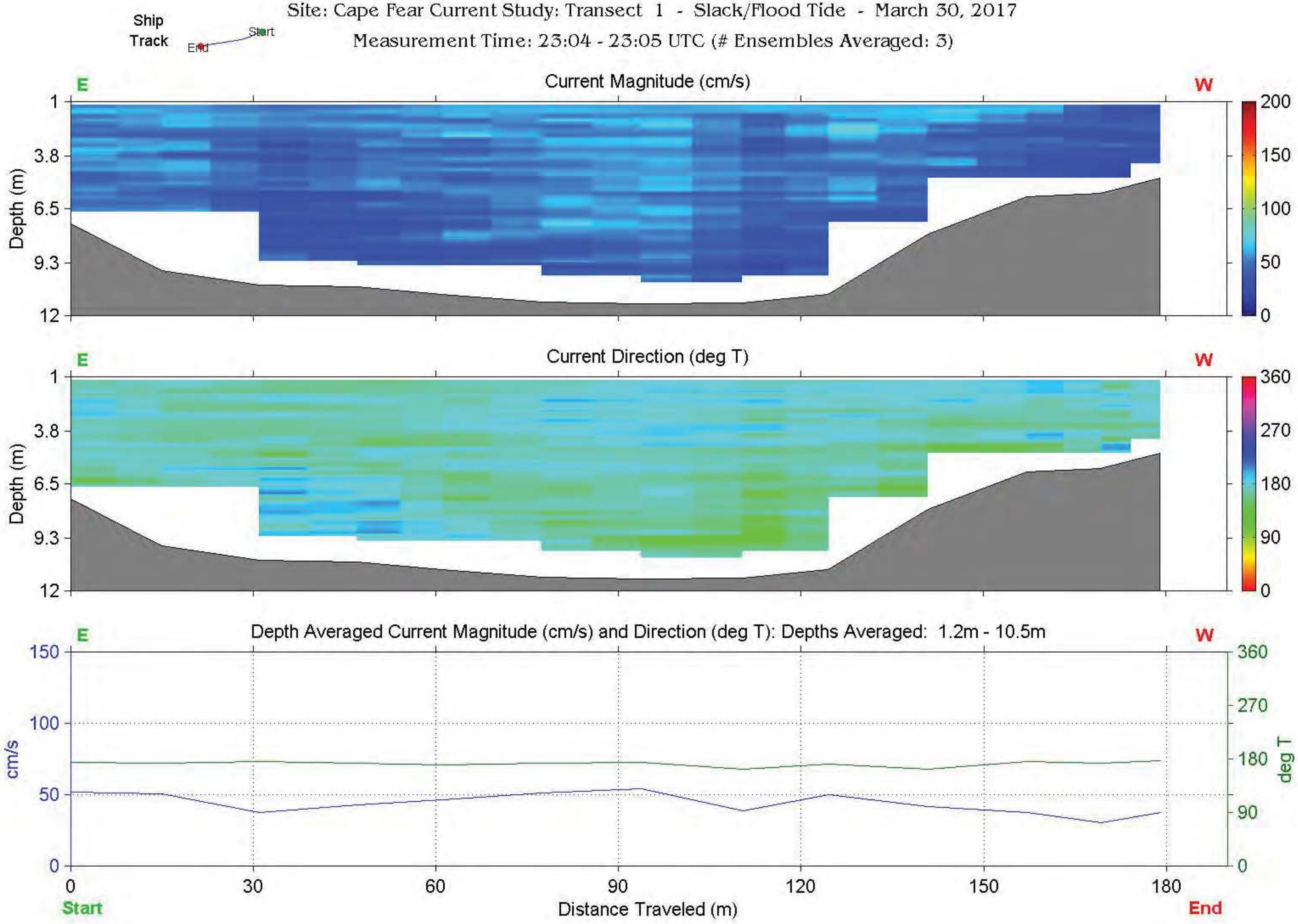
Measurement Time: 20:50 - 20:52 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 1 - Slack Tide - March 30, 2017

Measurement Time: 22:48 - 22:49 UTC (# Ensembles Averaged: 3)

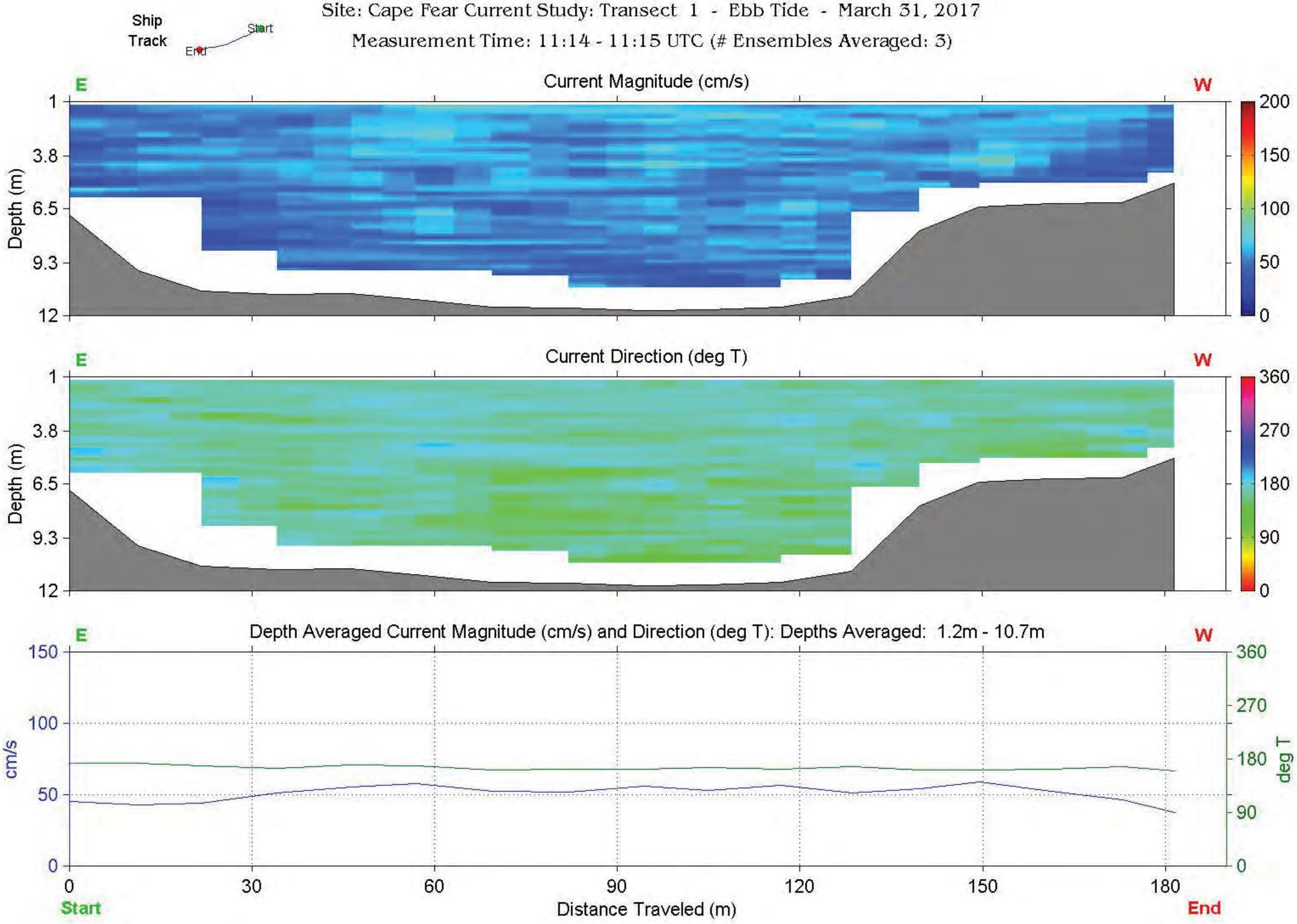


Site: Cape Fear Current Study: Transect 1 - Slack/Flood Tide - March 30, 2017

Measurement Time: 23:04 - 23:05 UTC (# Ensembles Averaged: 3)

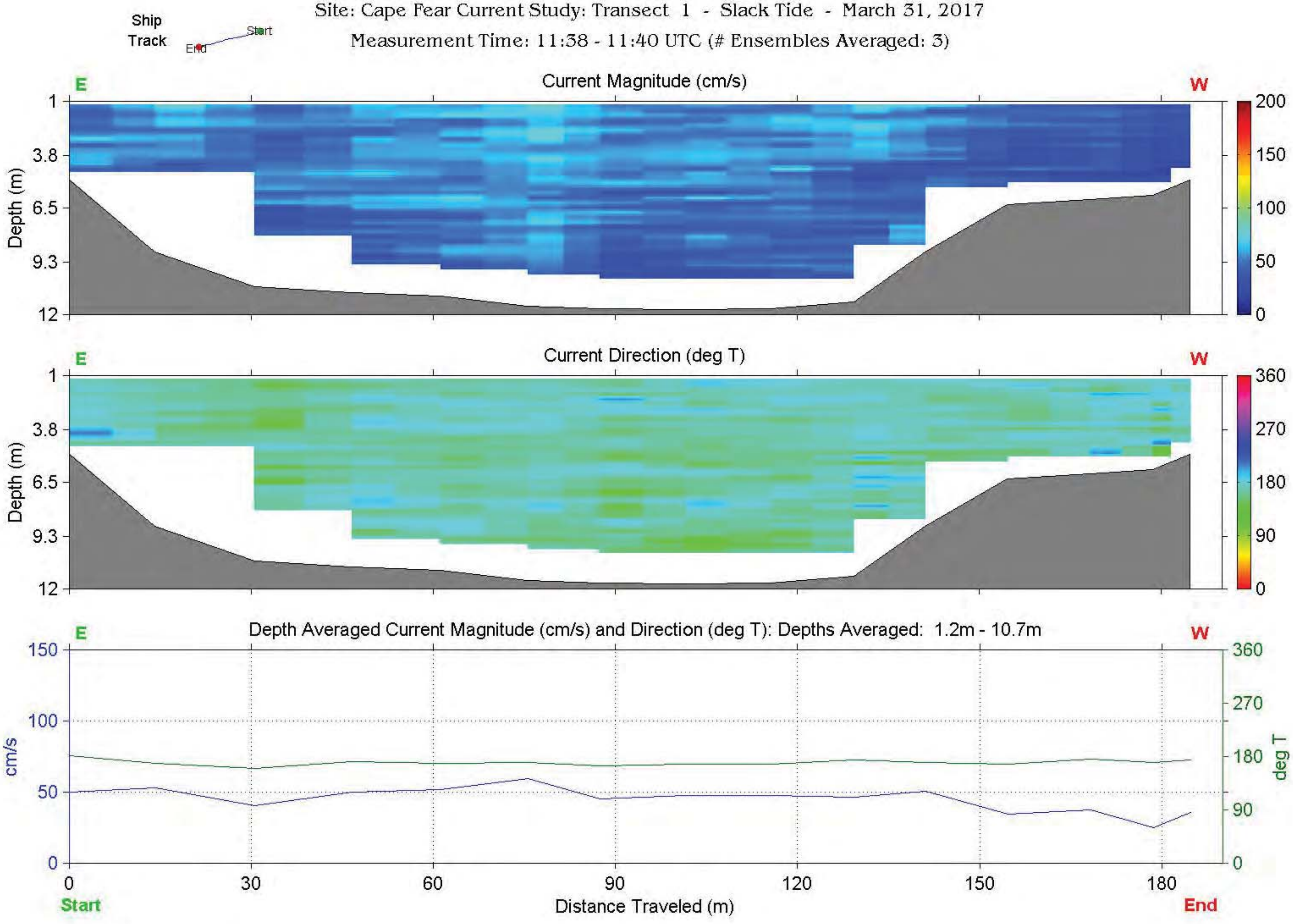
Site: Cape Fear Current Study: Transect 1 - Ebb Tide - March 31, 2017

Measurement Time: 11:14 - 11:15 UTC (# Ensembles Averaged: 3)



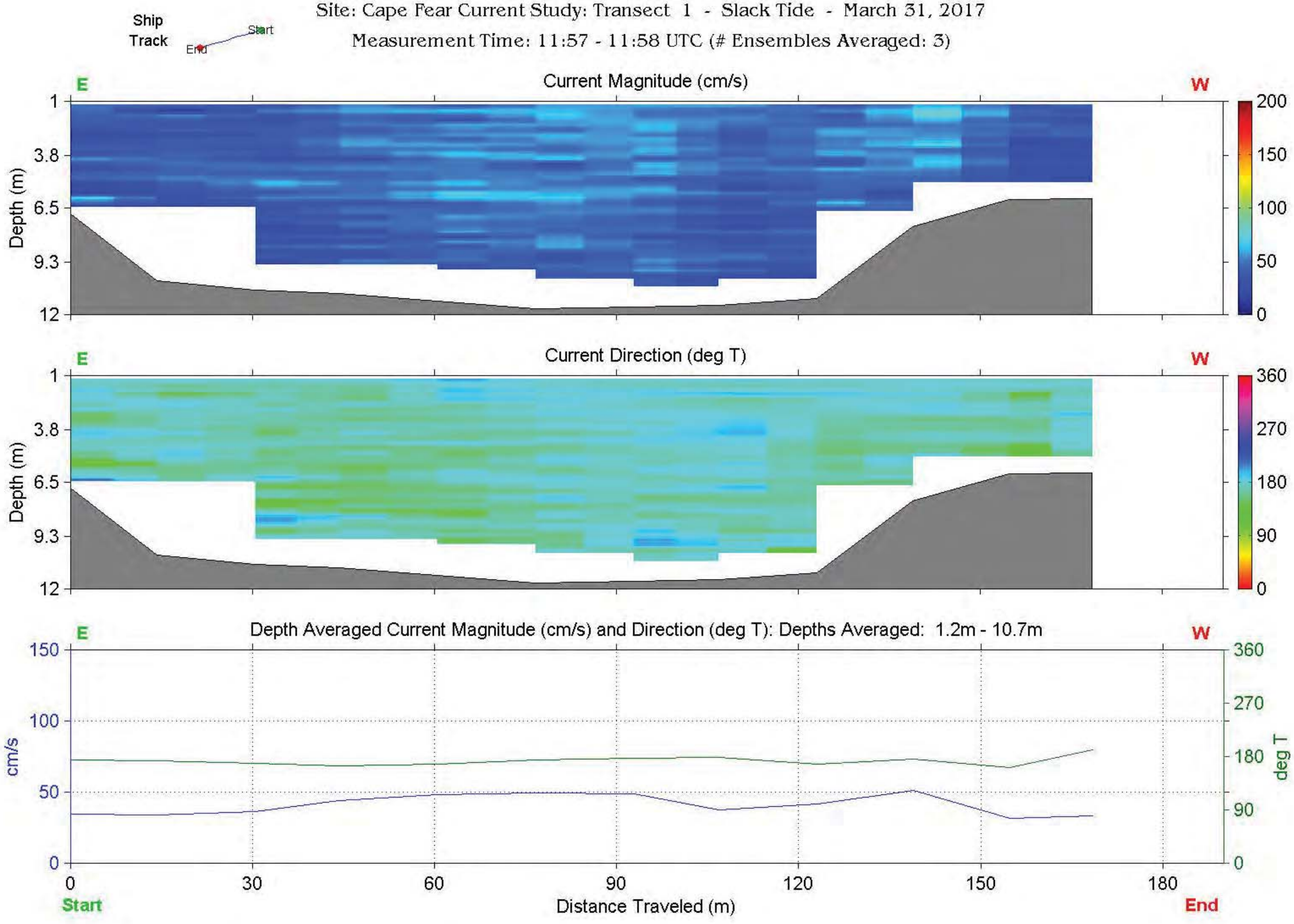
Site: Cape Fear Current Study: Transect 1 - Slack Tide - March 31, 2017

Measurement Time: 11:38 - 11:40 UTC (# Ensembles Averaged: 3)



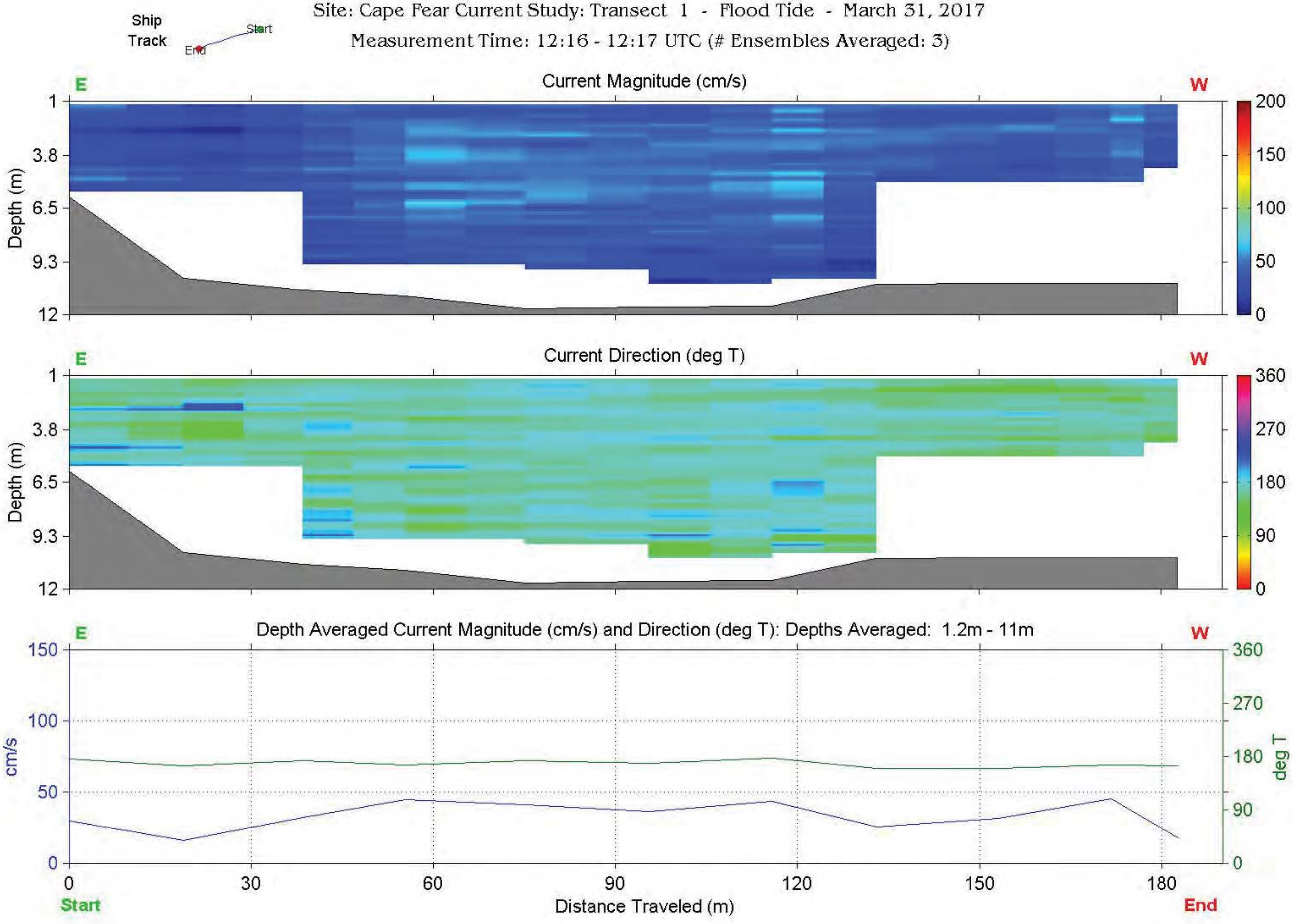
Site: Cape Fear Current Study: Transect 1 - Slack Tide - March 31, 2017

Measurement Time: 11:57 - 11:58 UTC (# Ensembles Averaged: 3)



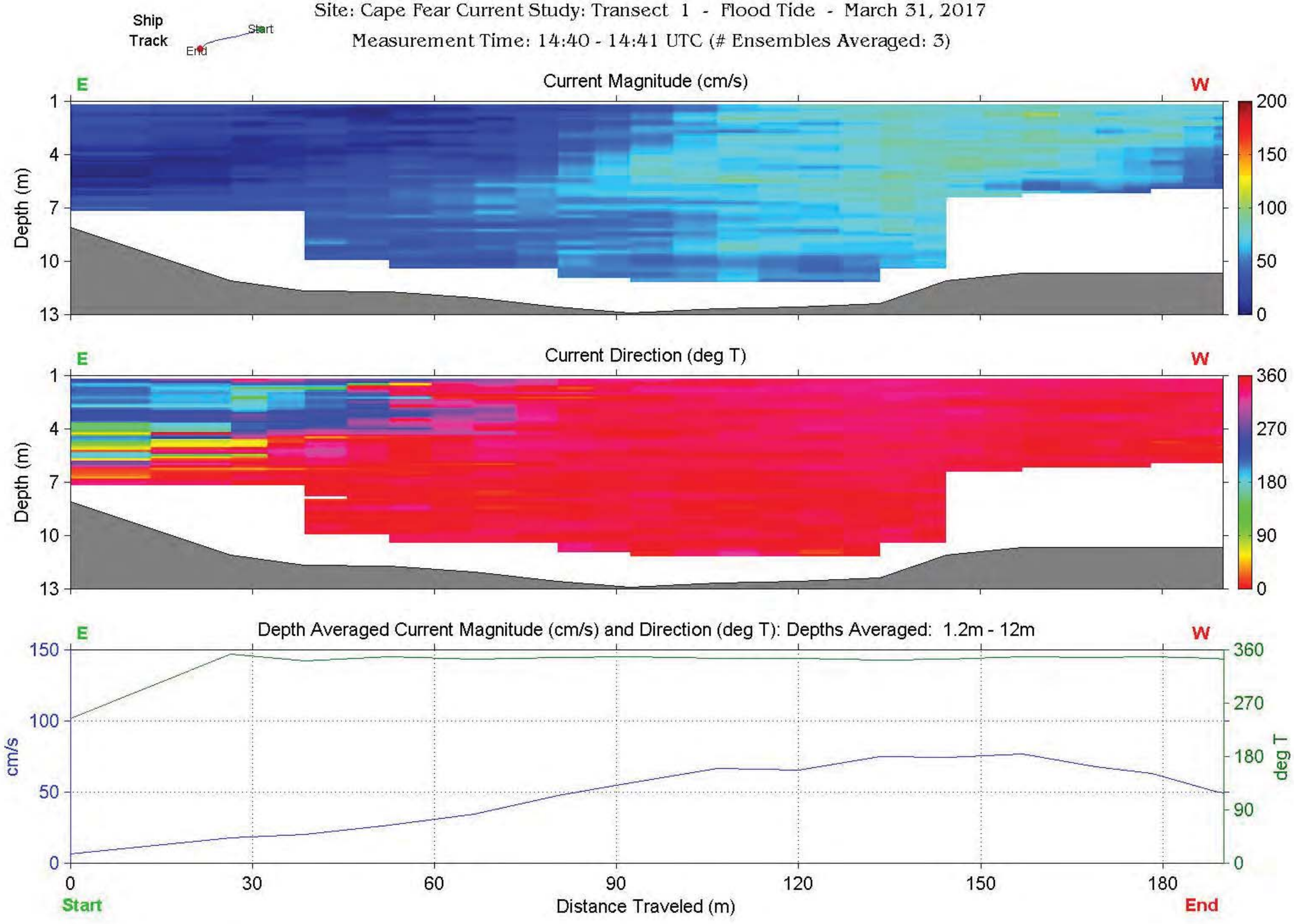
Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 31, 2017

Measurement Time: 12:16 - 12:17 UTC (# Ensembles Averaged: 3)



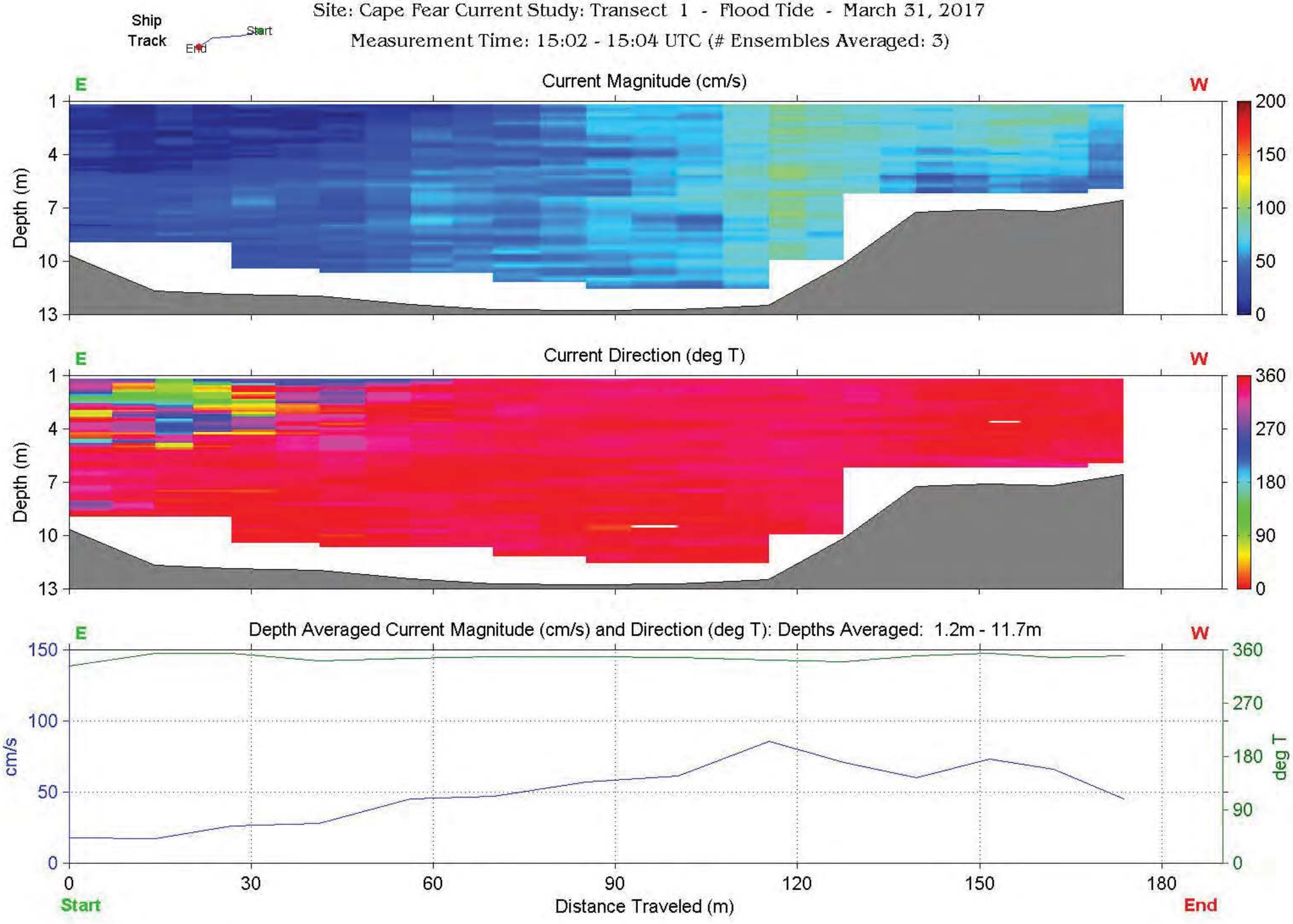
Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 31, 2017

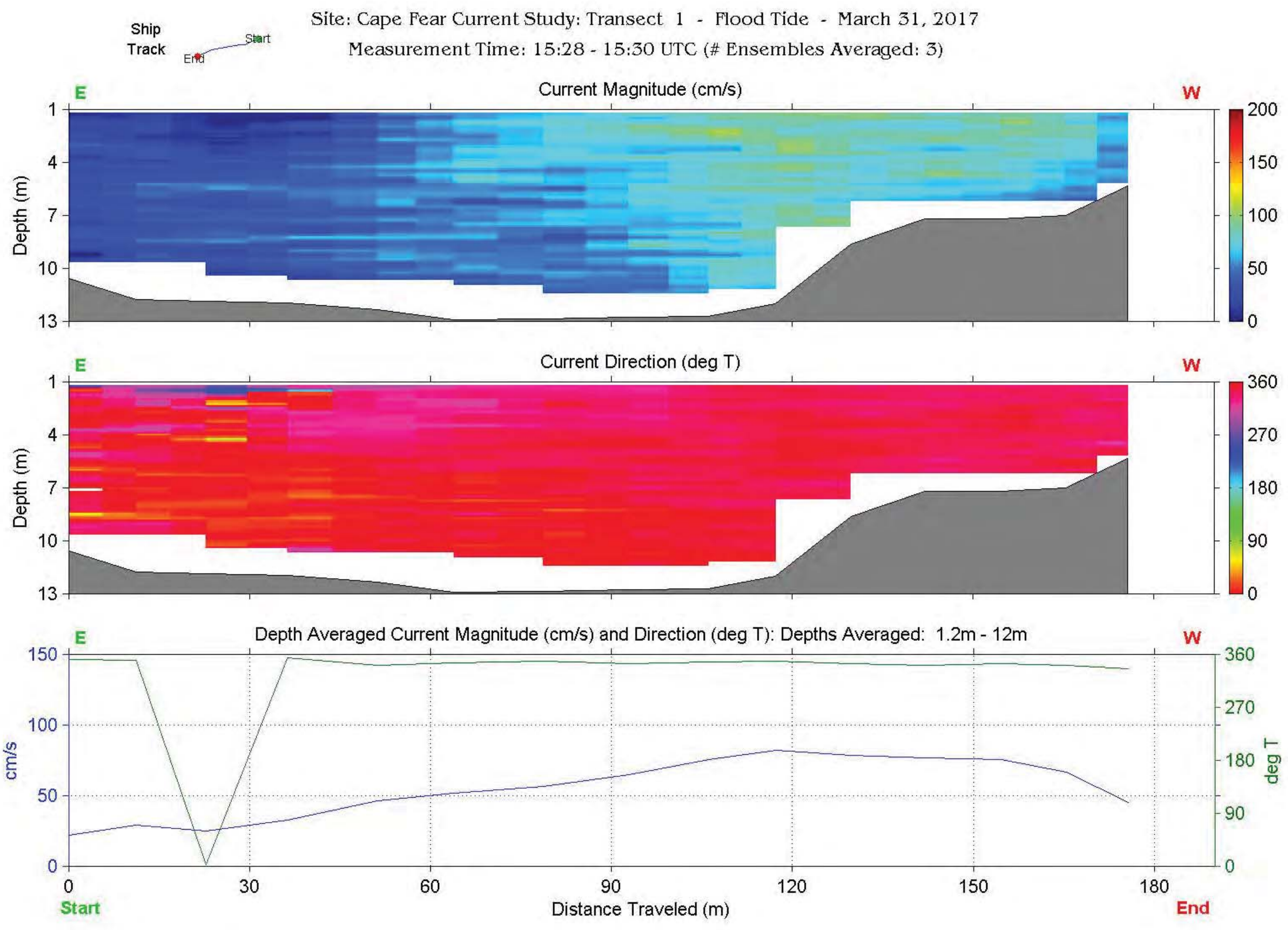
Measurement Time: 14:40 - 14:41 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 31, 2017

Measurement Time: 15:02 - 15:04 UTC (# Ensembles Averaged: 3)





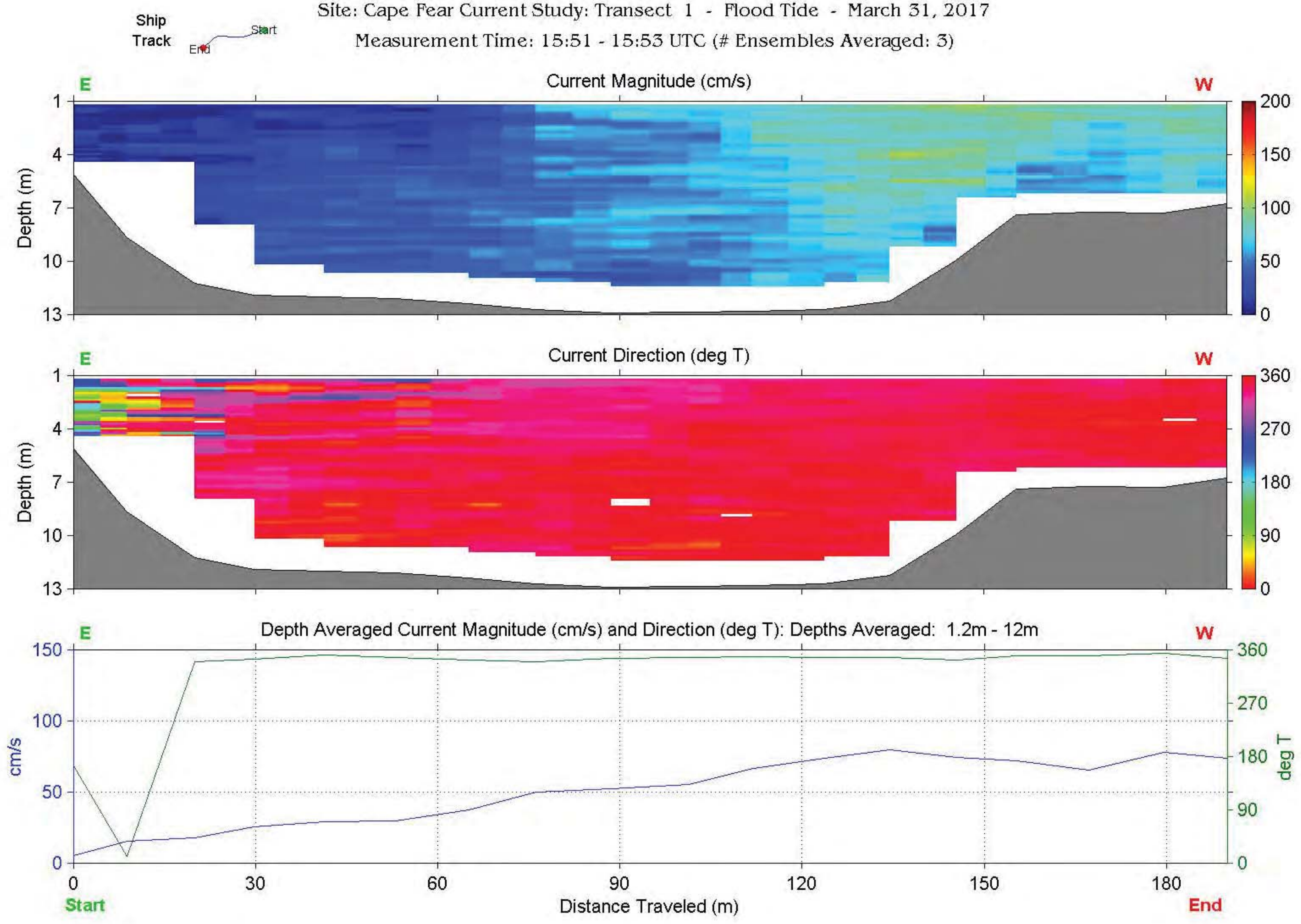
Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 31, 2017

Measurement Time: 15:28 - 15:30 UTC (# Ensembles Averaged: 3)

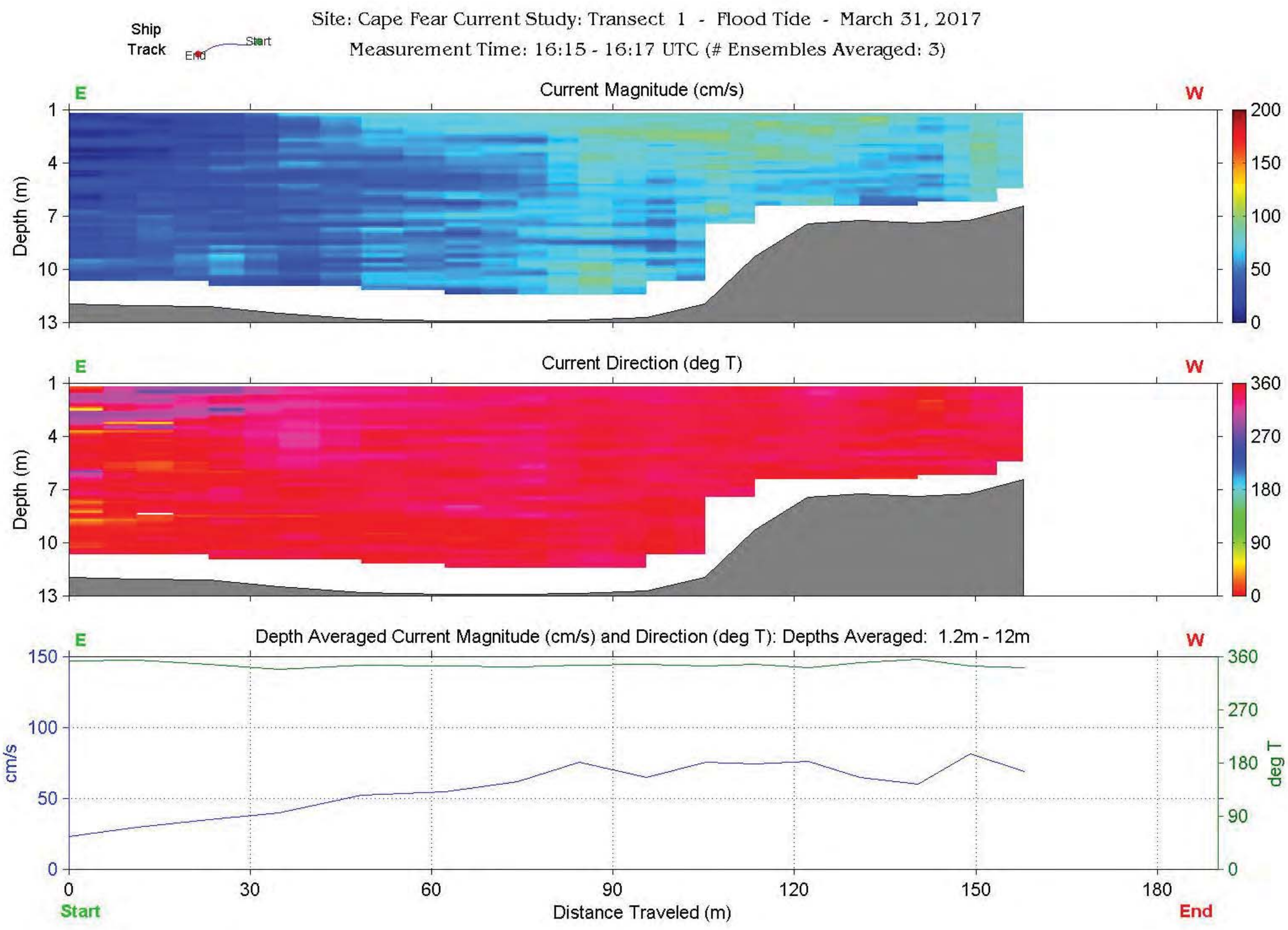
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 12m


Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 31, 2017

Measurement Time: 15:51 - 15:53 UTC (# Ensembles Averaged: 3)



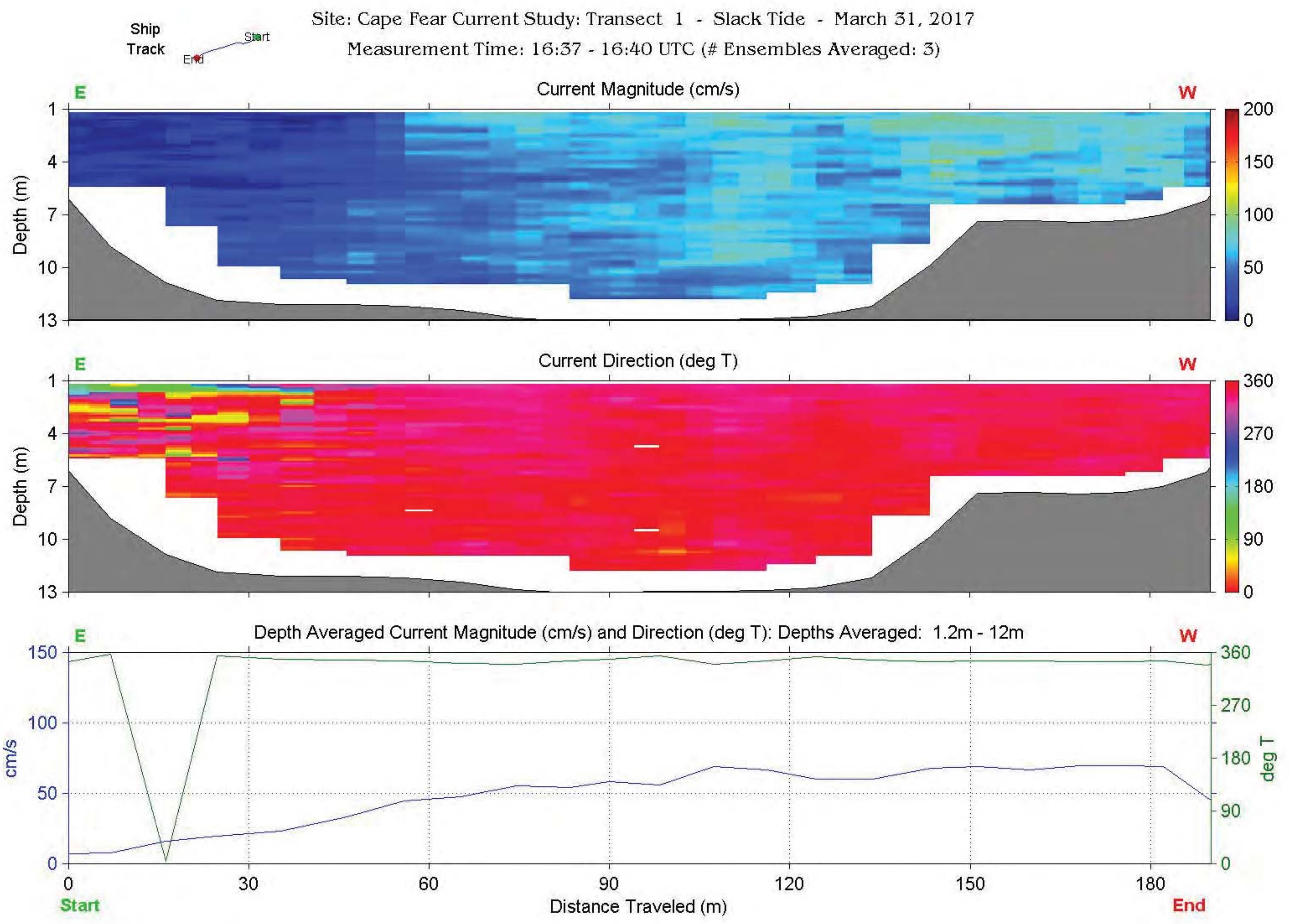
Site: Cape Fear Current Study: Transect 1 - Flood Tide - March 31, 2017

Measurement Time: 16:15 - 16:17 UTC (# Ensembles Averaged: 3)

Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 12m

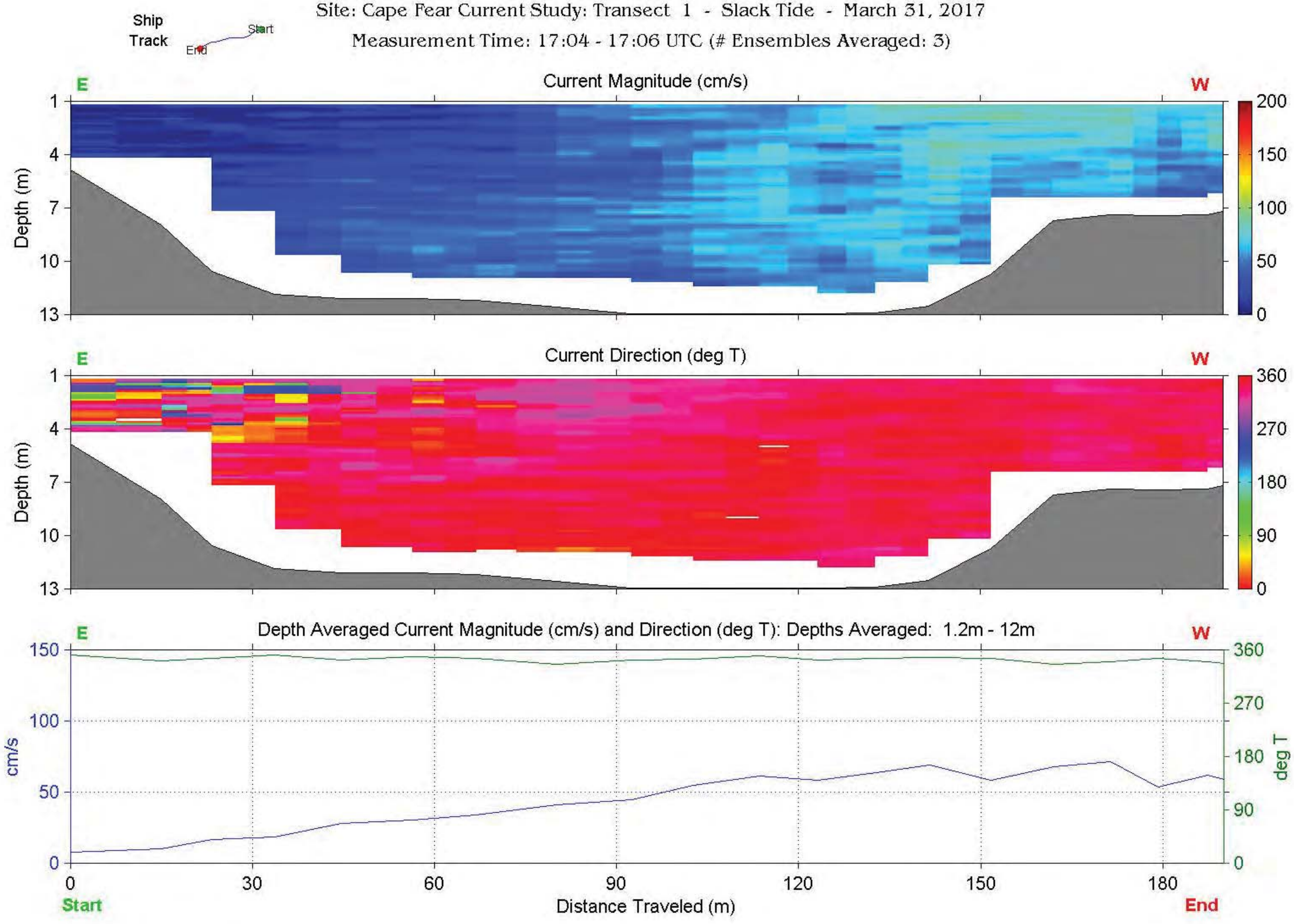


Site: Cape Fear Current Study: Transect 1 - Slack Tide - March 31, 2017

Measurement Time: 16:37 - 16:40 UTC (# Ensembles Averaged: 3)

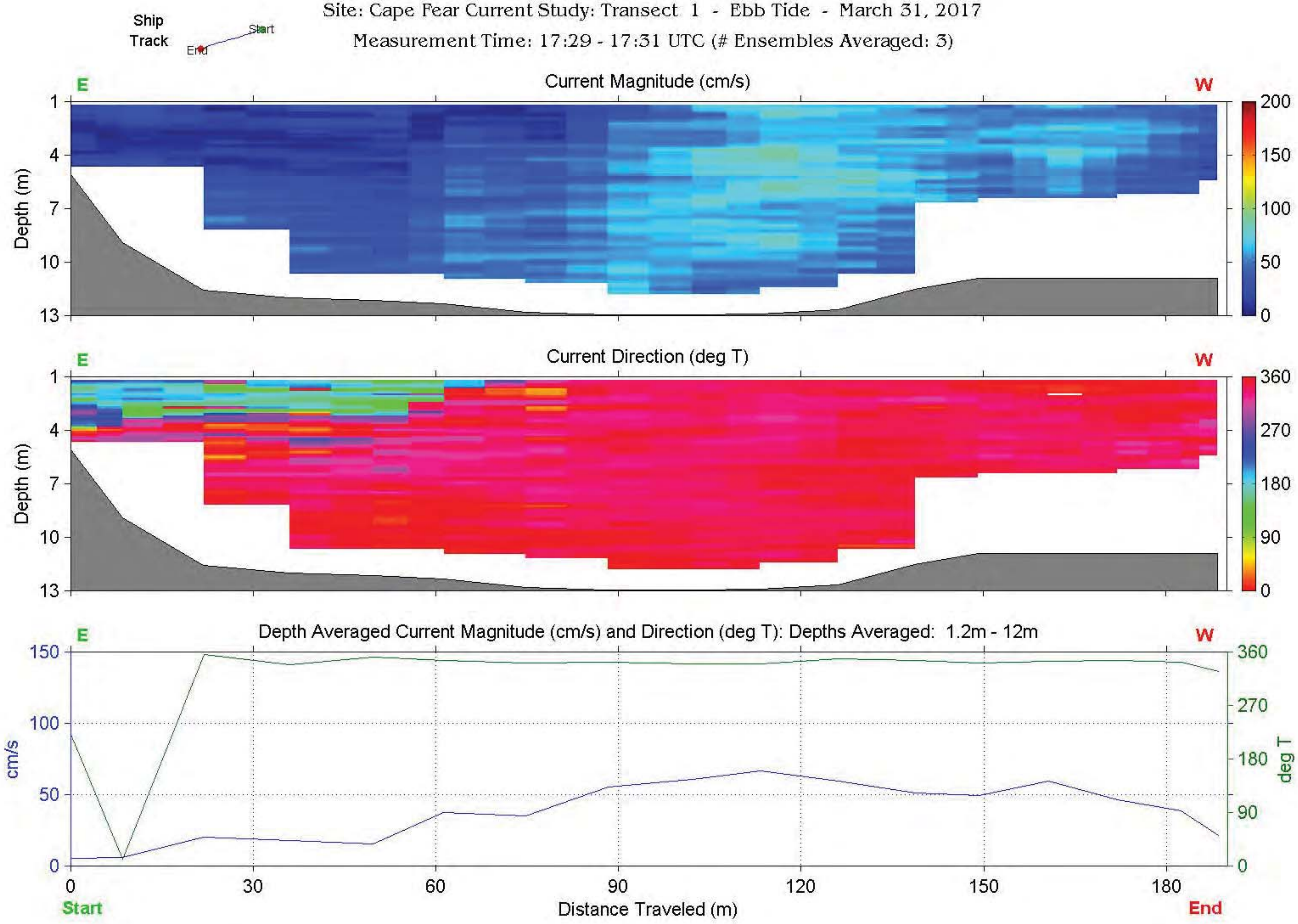
Site: Cape Fear Current Study: Transect 1 - Slack Tide - March 31, 2017

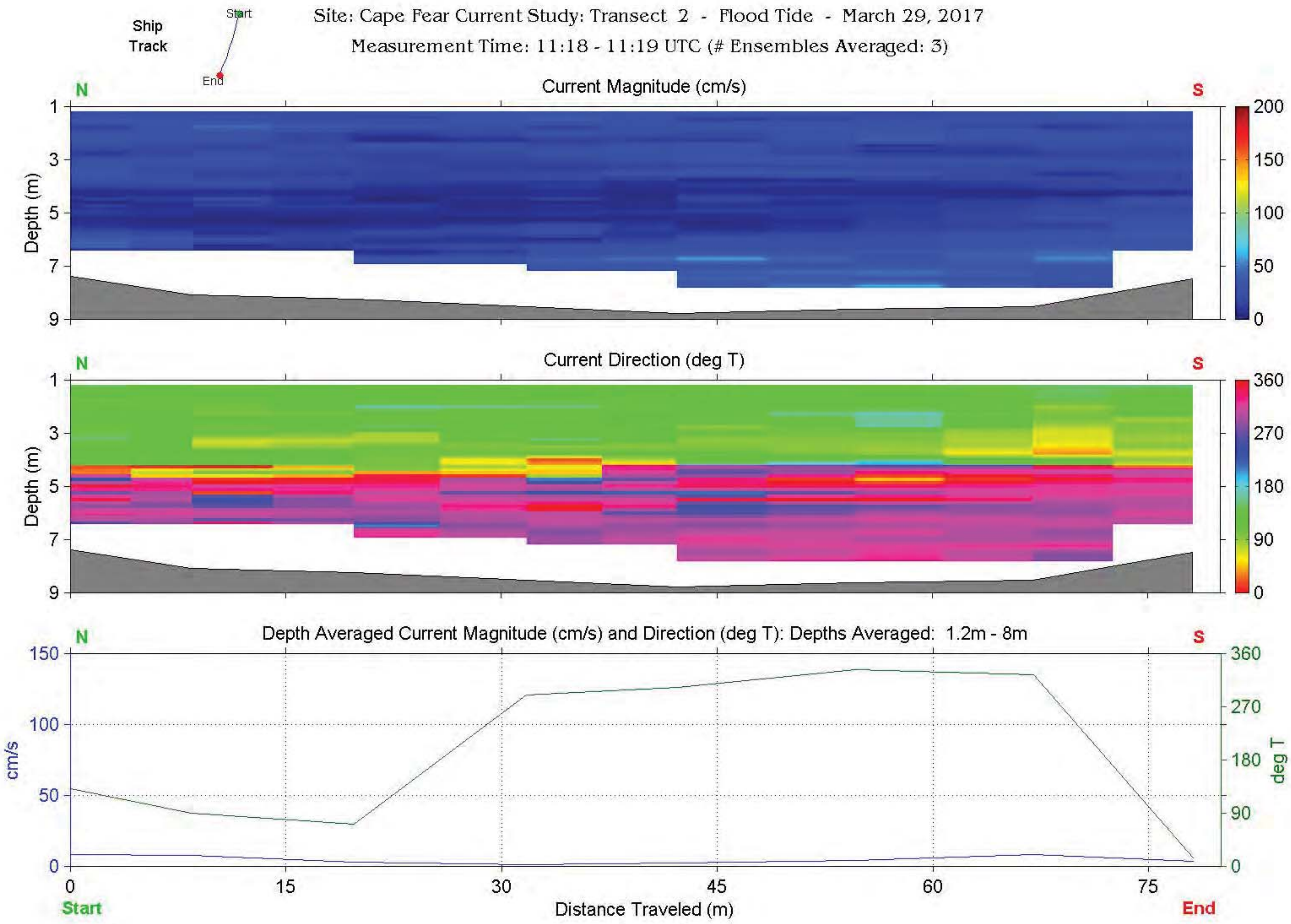
Measurement Time: 17:04 - 17:06 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 1 - Ebb Tide - March 31, 2017

Measurement Time: 17:29 - 17:31 UTC (# Ensembles Averaged: 3)





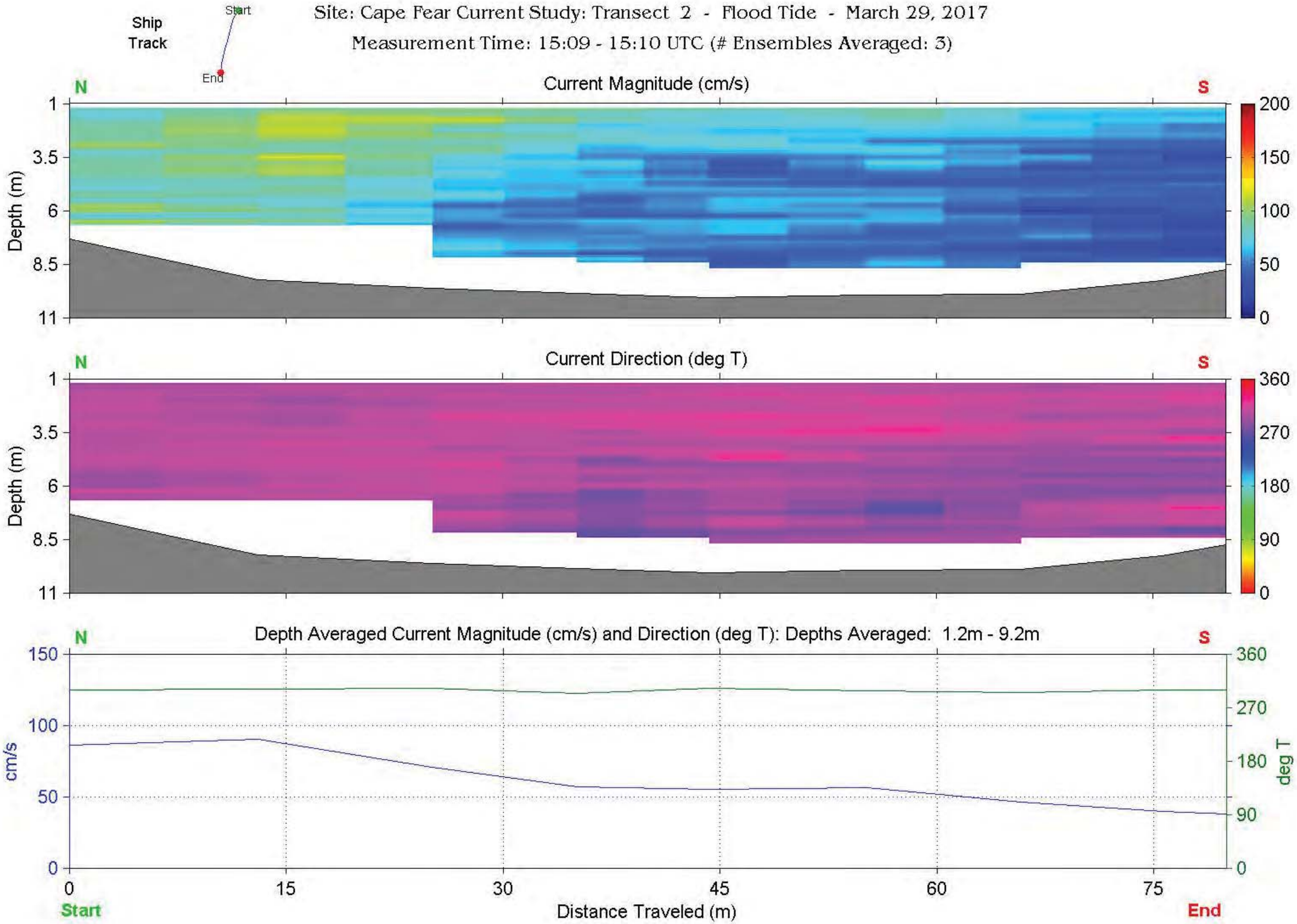
Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 29, 2017

Measurement Time: 11:18 - 11:19 UTC (# Ensembles Averaged: 3)

Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 8m



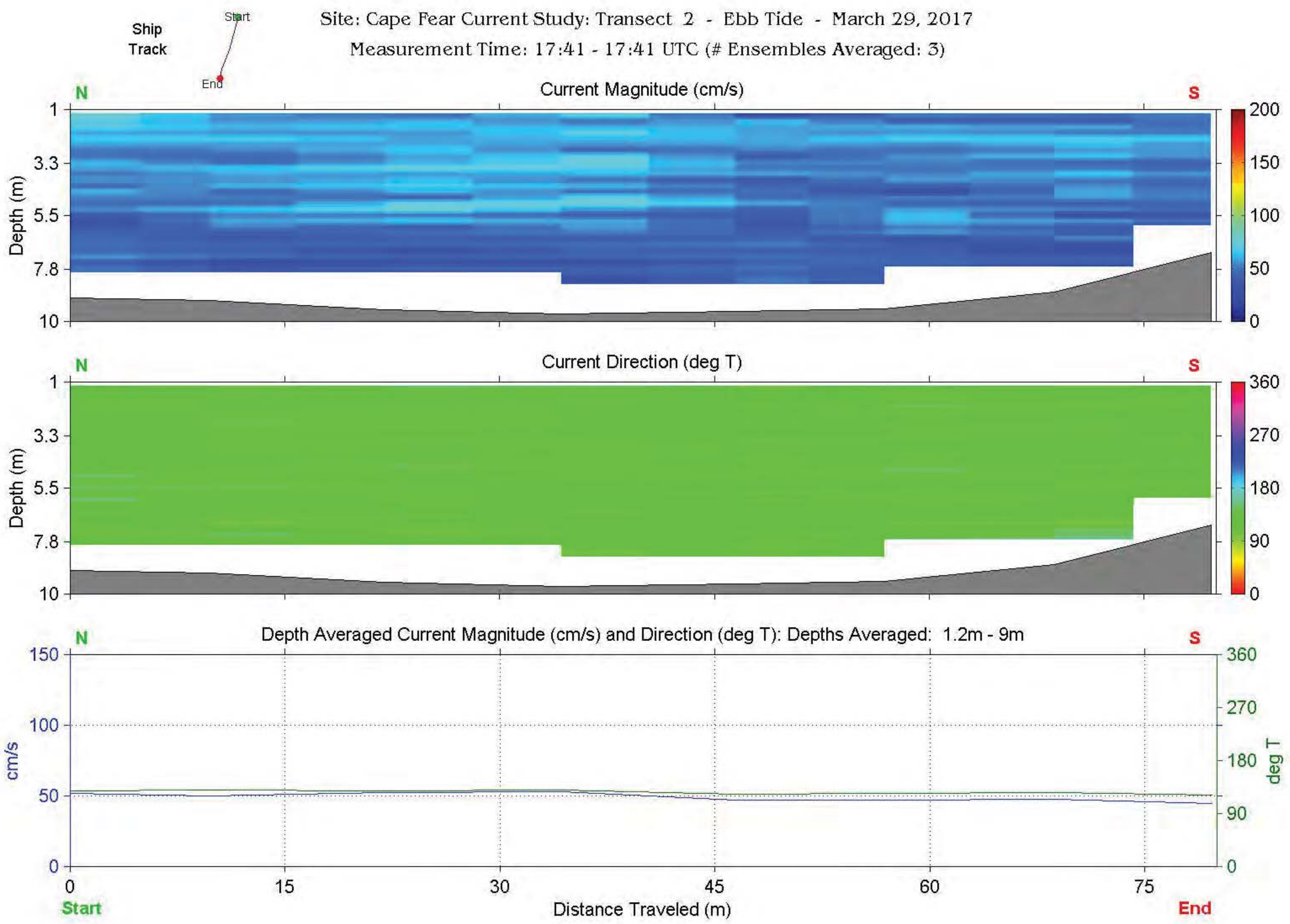
Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 29, 2017

Measurement Time: 15:09 - 15:10 UTC (# Ensembles Averaged: 3)

Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 9.2m

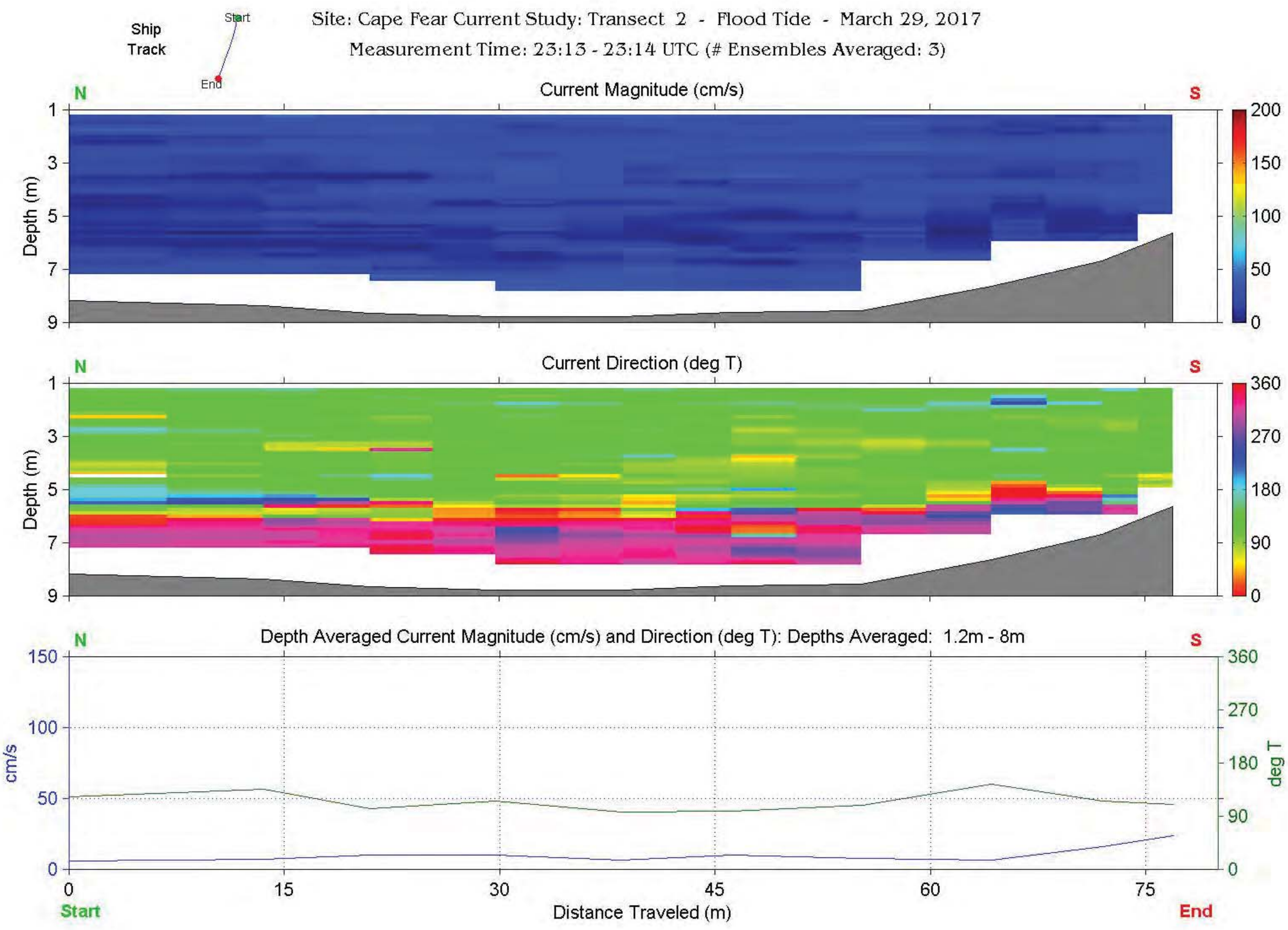


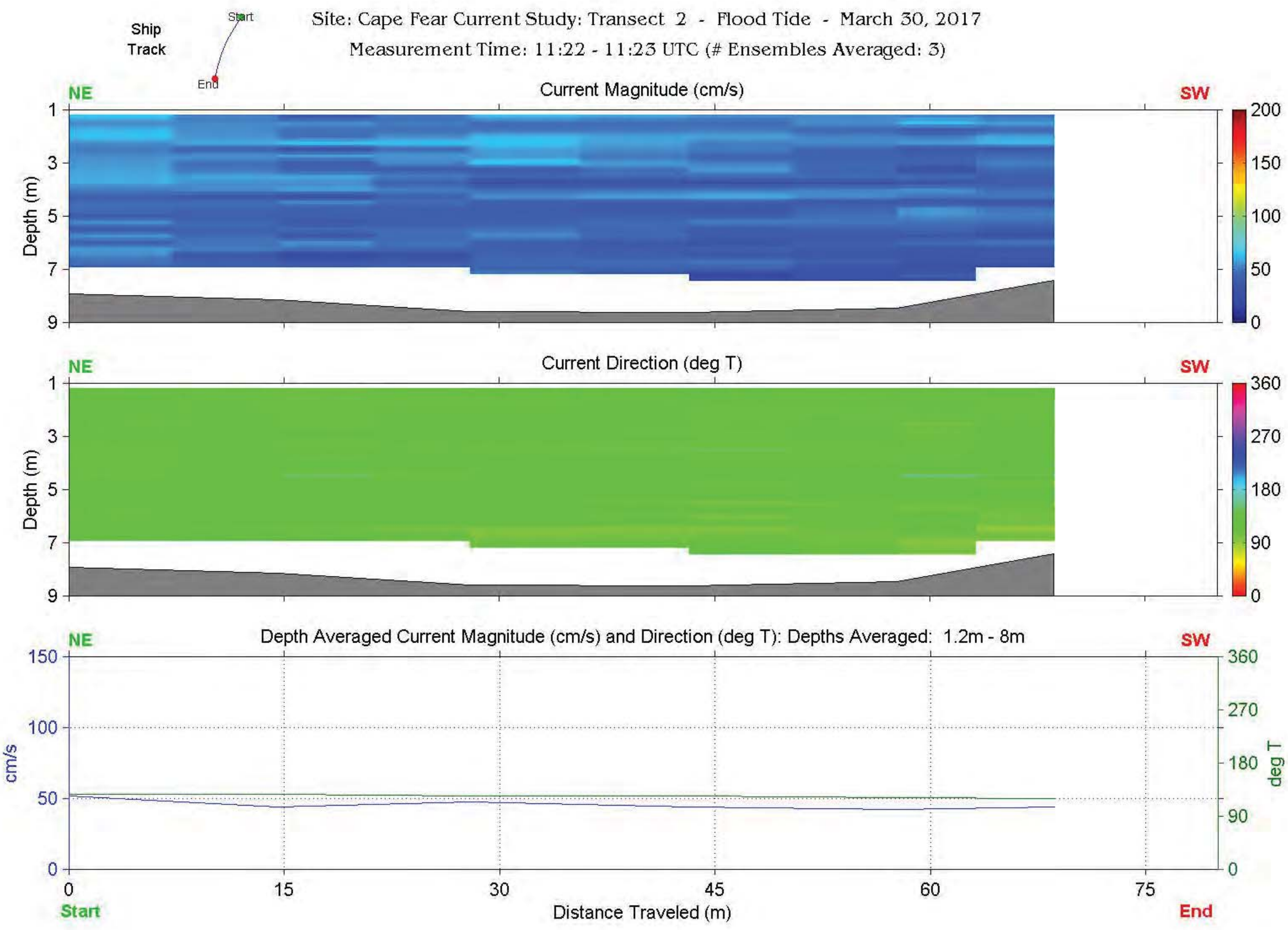
Site: Cape Fear Current Study: Transect 2 - Ebb Tide - March 29, 2017

Measurement Time: 17:41 - 17:41 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 29, 2017

Measurement Time: 23:13 - 23:14 UTC (# Ensembles Averaged: 3)

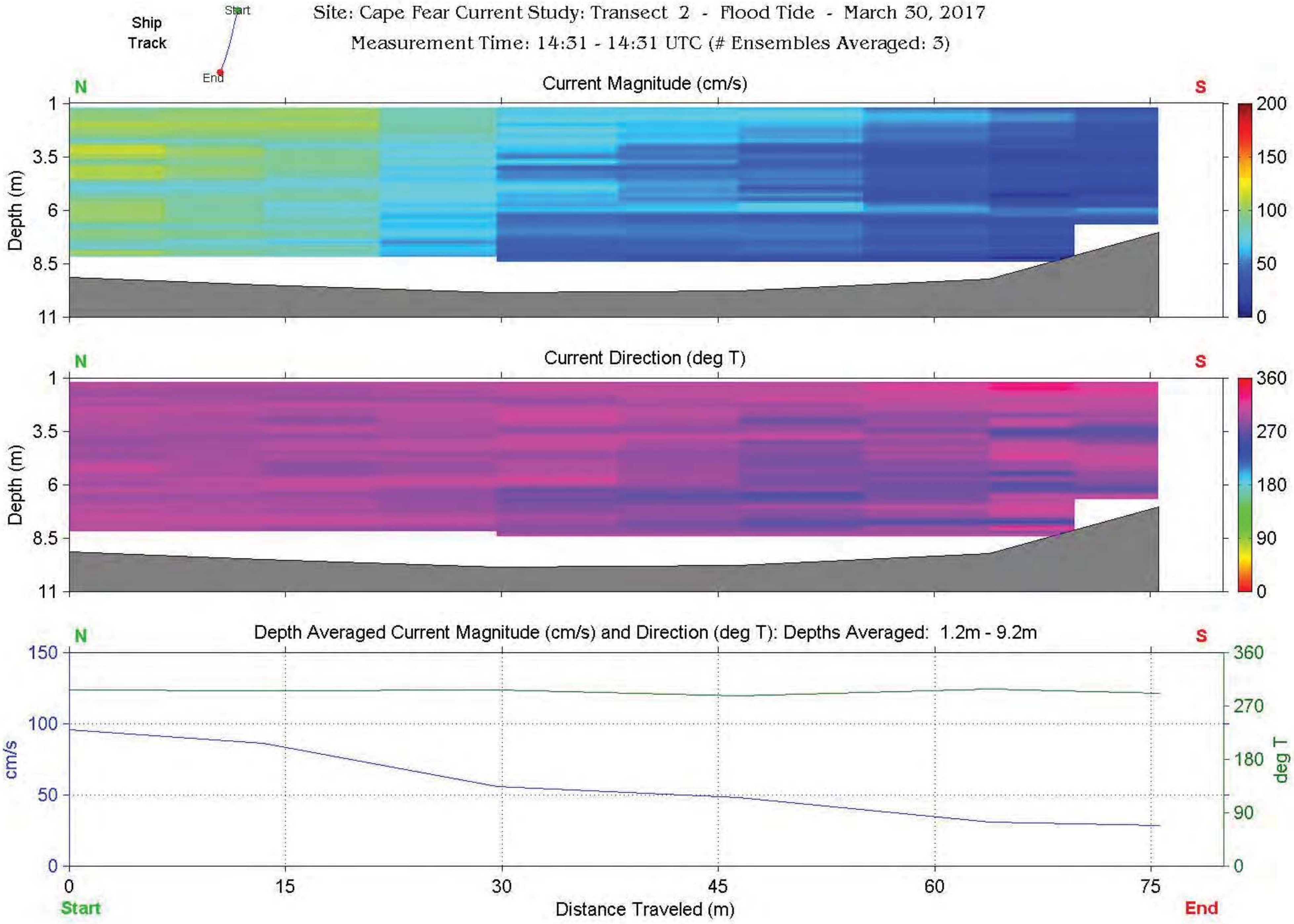



Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 30, 2017

Measurement Time: 11:22 - 11:23 UTC (# Ensembles Averaged: 3)

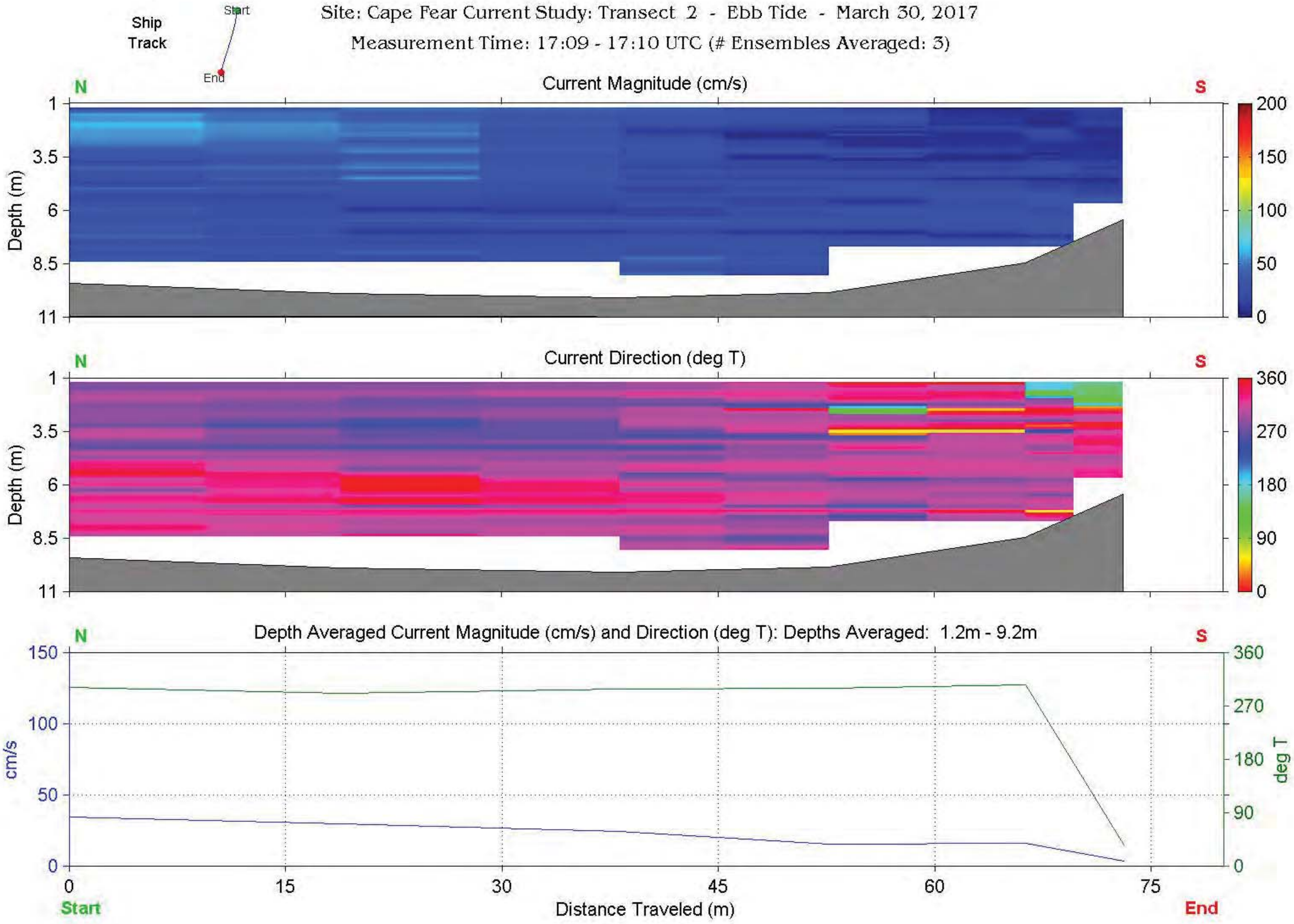
Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 30, 2017

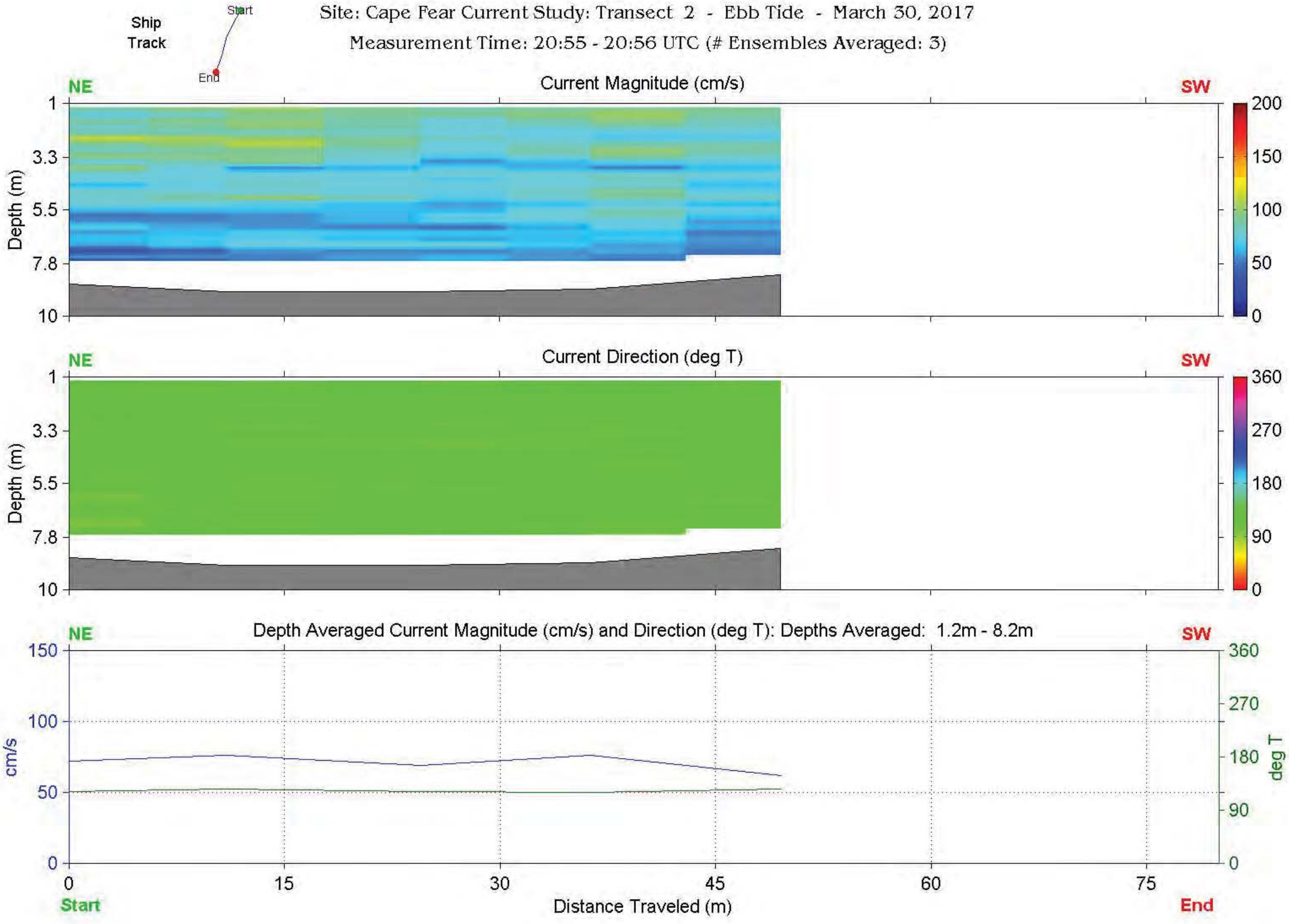
Measurement Time: 14:31 - 14:31 UTC (# Ensembles Averaged: 3)

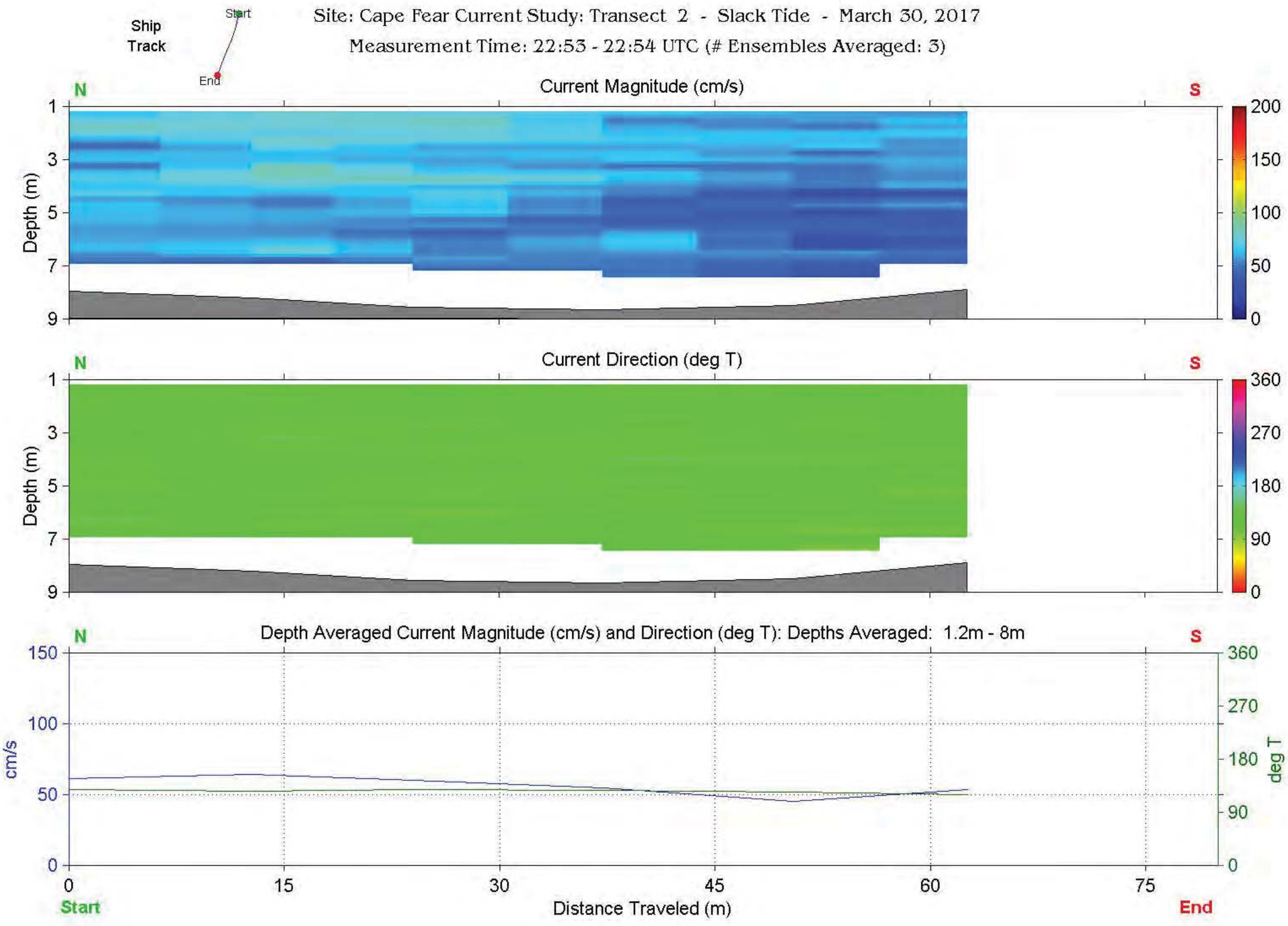


Site: Cape Fear Current Study: Transect 2 - Ebb Tide - March 30, 2017

Measurement Time: 17:09 - 17:10 UTC (# Ensembles Averaged: 3)




Ship Track
Start
End
Site: Cape Fear Current Study: Transect 2 - Ebb Tide - March 30, 2017
Measurement Time: 20:55 - 20:56 UTC (# Ensembles Averaged: 3)
NE
Current Magnitude (cm/s)
SW
Depth (m)
1
3.3
5.5
7.8
10
200
150
100
50
0
NE
Current Direction (deg T)
SW
Depth (m)
1
3.3
5.5
7.8
10
360
270
180
90
0
NE
Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 8.2m
SW
cm/s
150
100
50
0
deg T
360
270
180
90
0
0
15
30
45
60
75
Start
Distance Traveled (m)
End

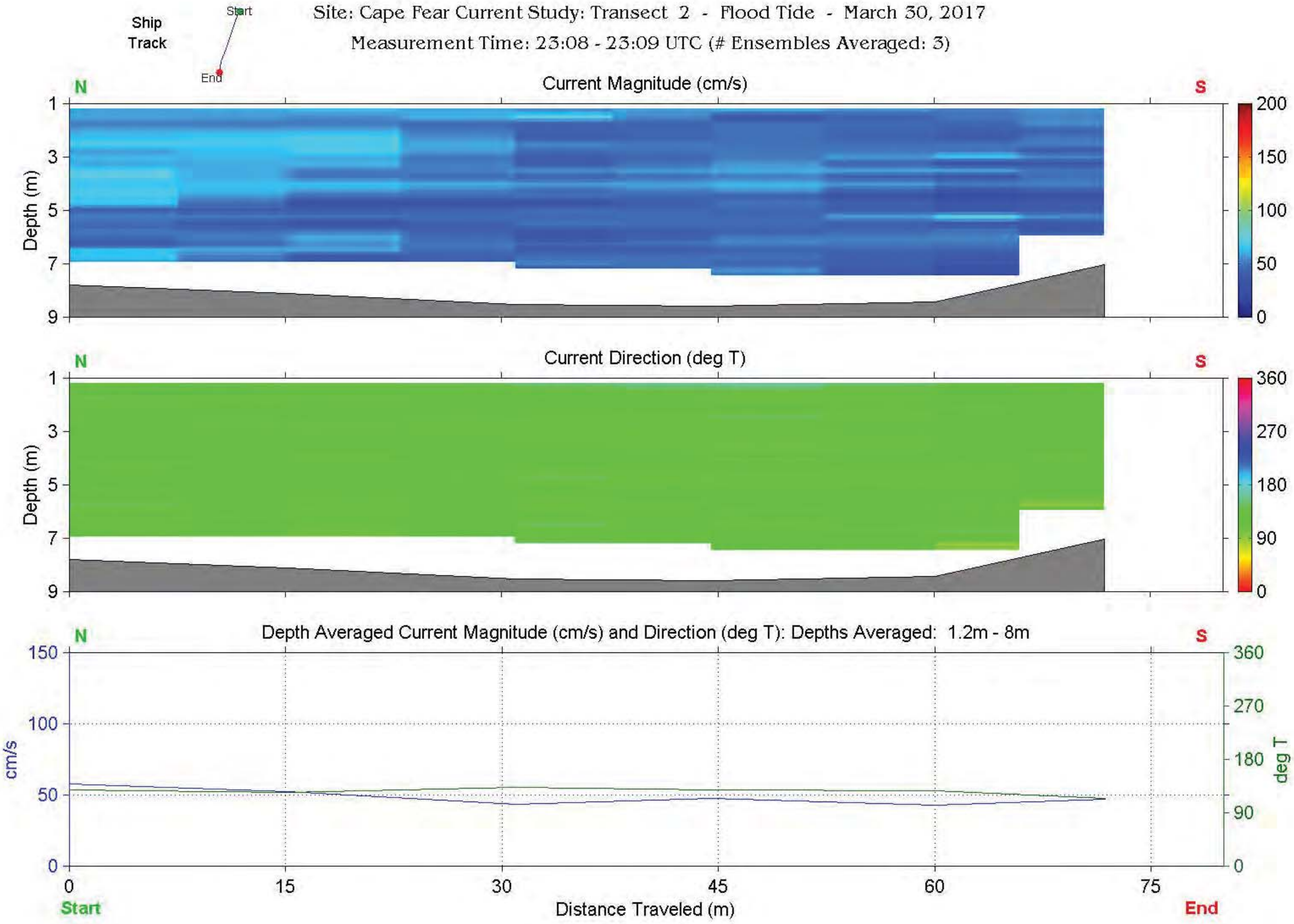


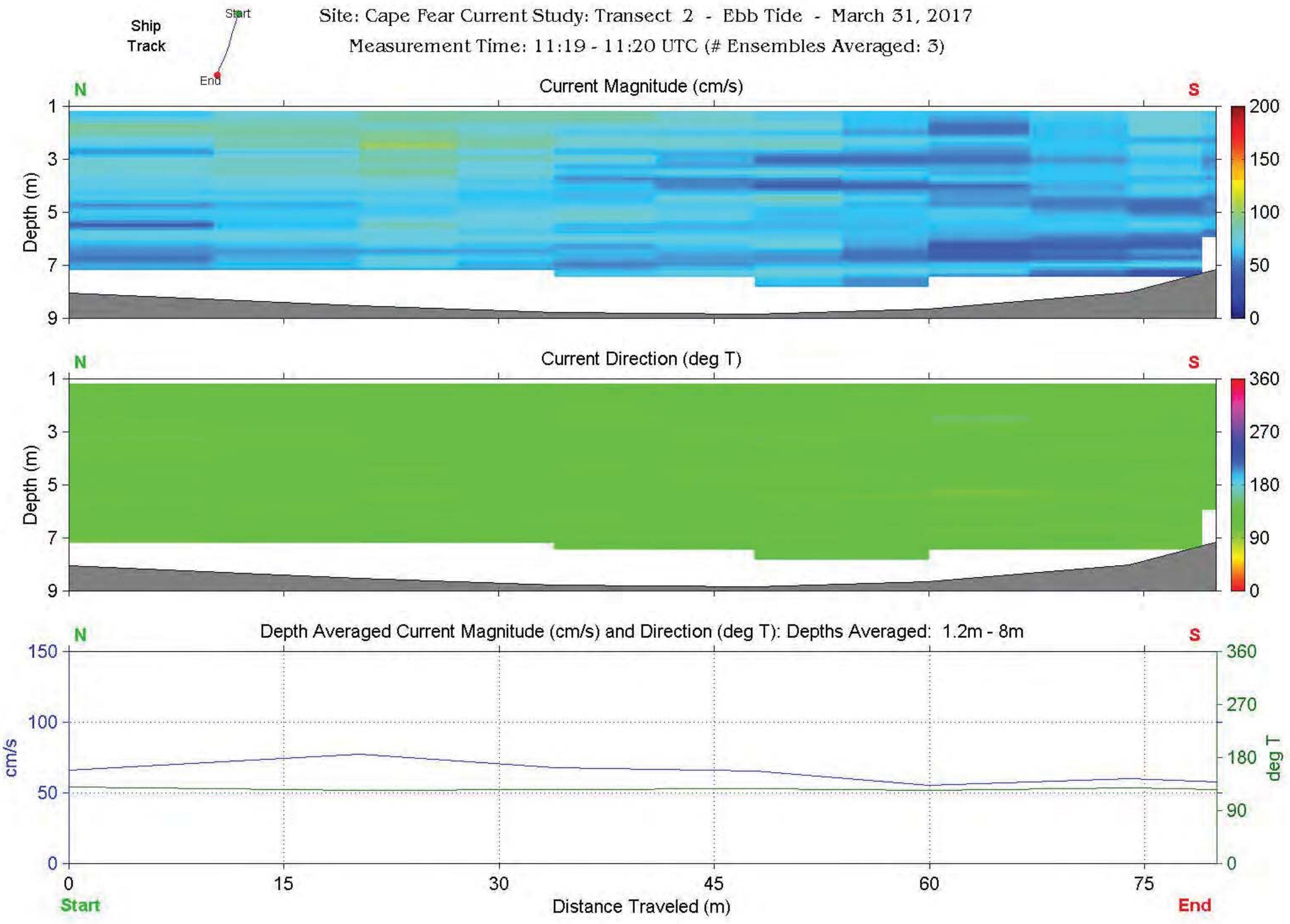
Site: Cape Fear Current Study: Transect 2 - Slack Tide - March 30, 2017

Measurement Time: 22:53 - 22:54 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 30, 2017

Measurement Time: 23:08 - 23:09 UTC (# Ensembles Averaged: 3)



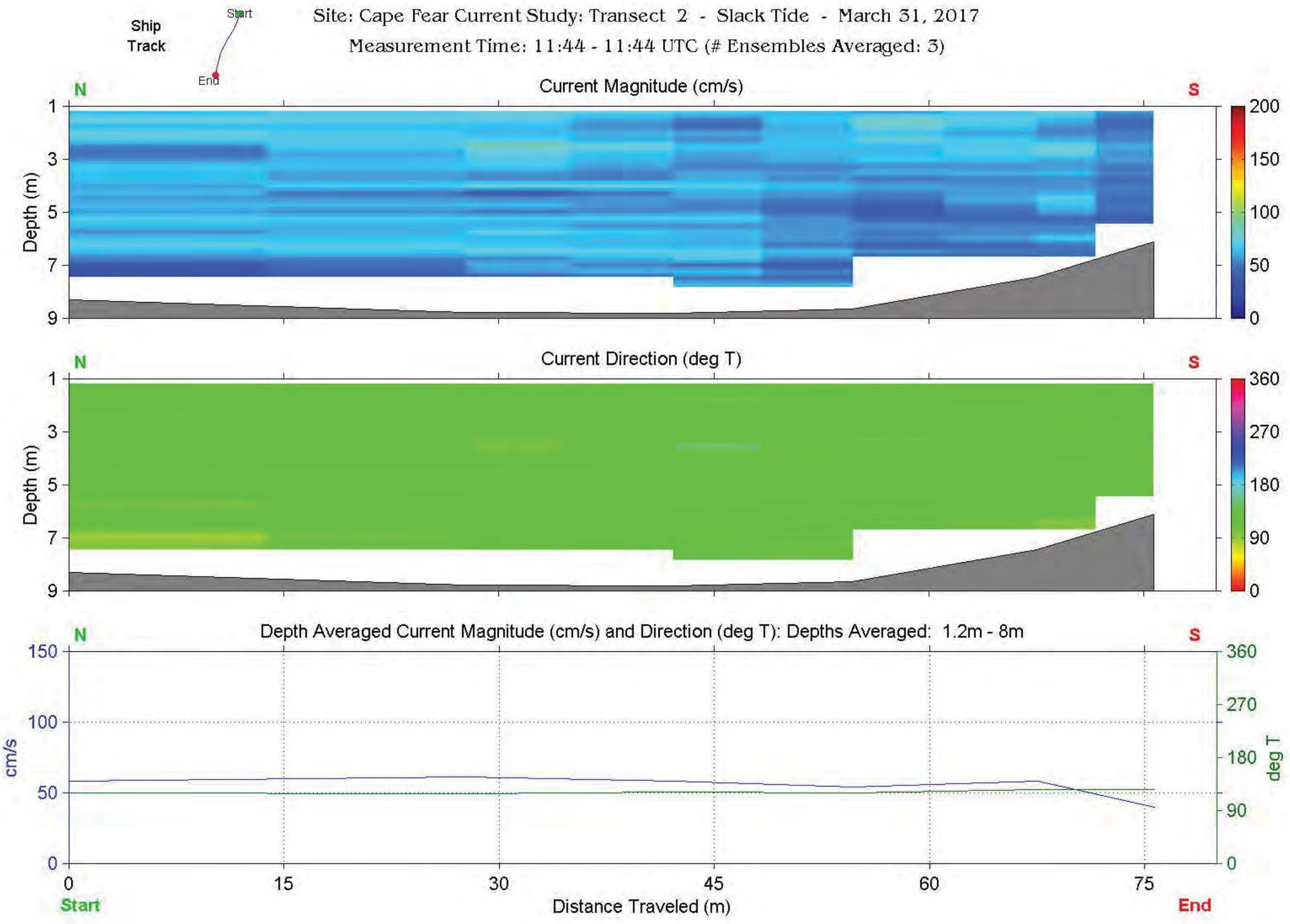


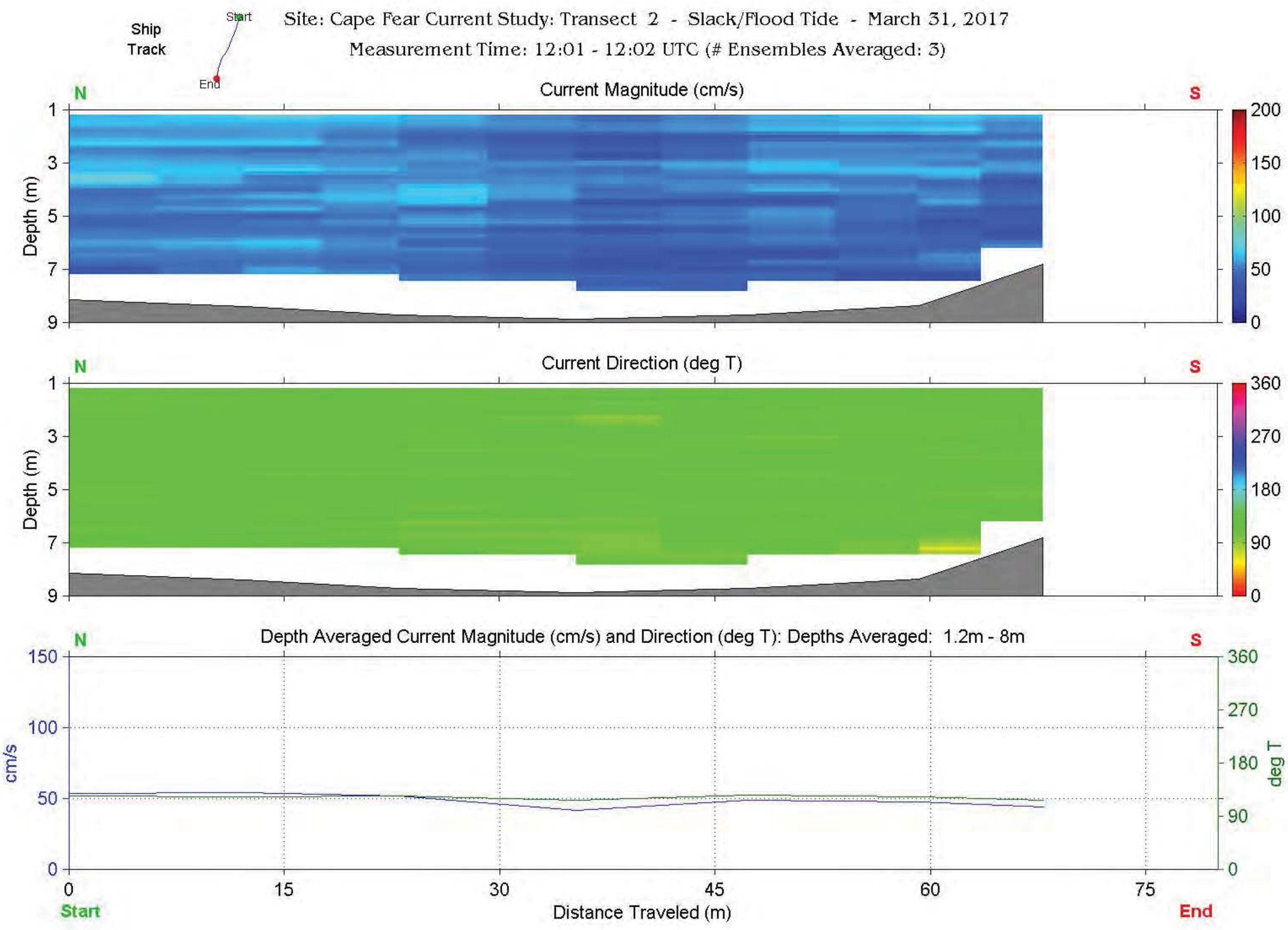
Site: Cape Fear Current Study: Transect 2 - Ebb Tide - March 31, 2017

Measurement Time: 11:19 - 11:20 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 2 - Slack Tide - March 31, 2017

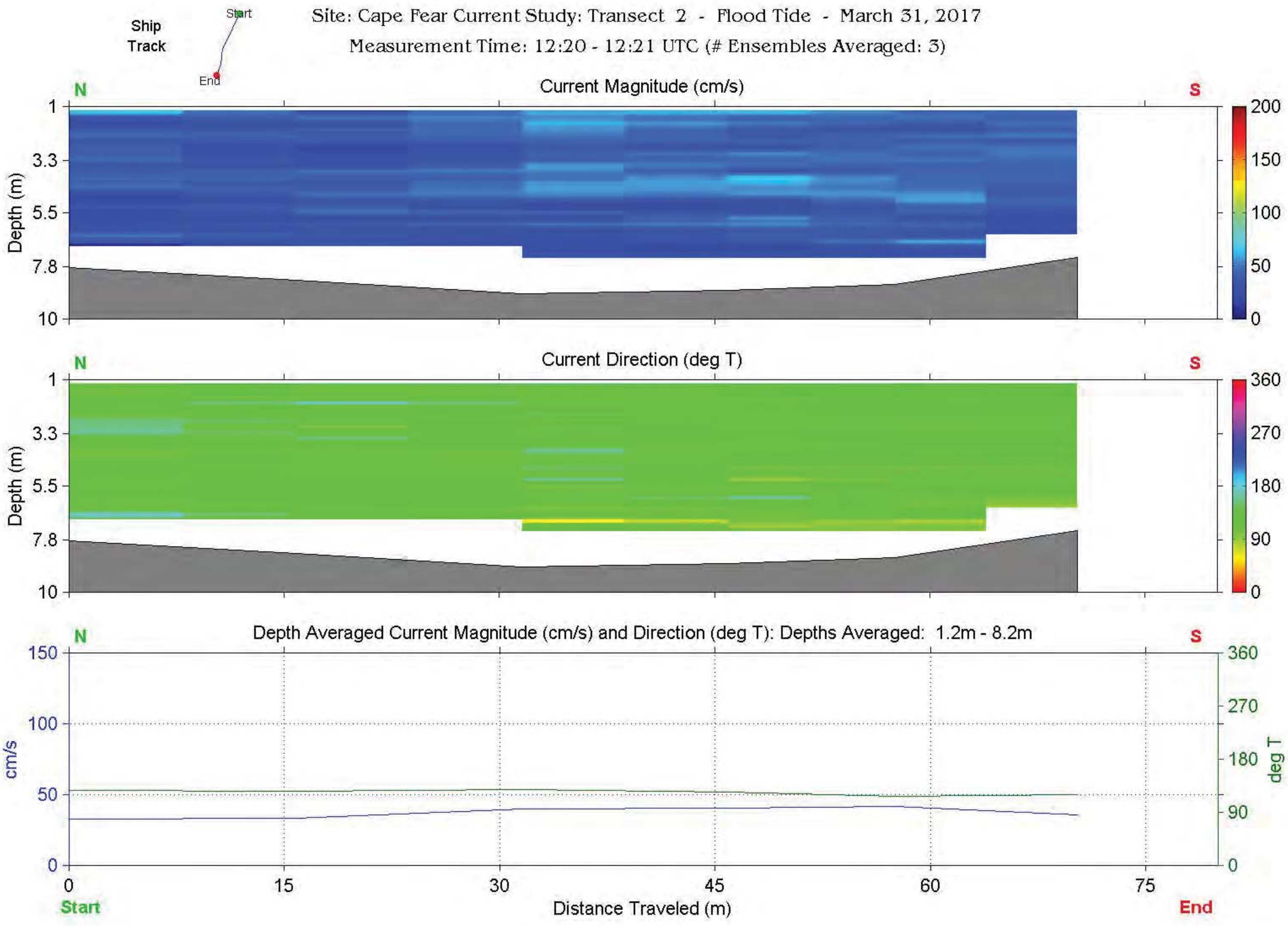
Measurement Time: 11:44 - 11:44 UTC (# Ensembles Averaged: 3)





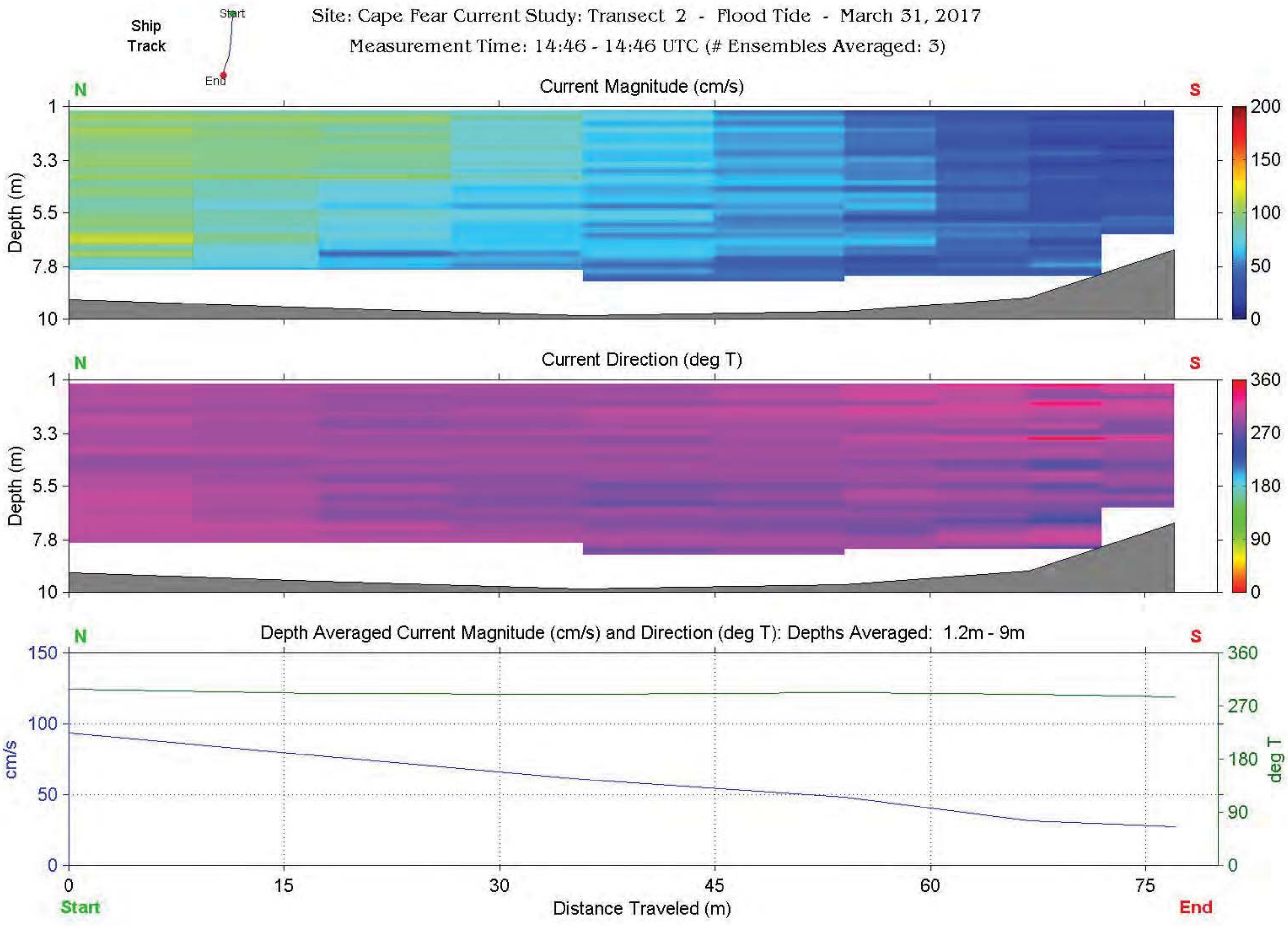
Site: Cape Fear Current Study: Transect 2 - Slack/Flood Tide - March 31, 2017

Measurement Time: 12:01 - 12:02 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 31, 2017

Measurement Time: 12:20 - 12:21 UTC (# Ensembles Averaged: 3)

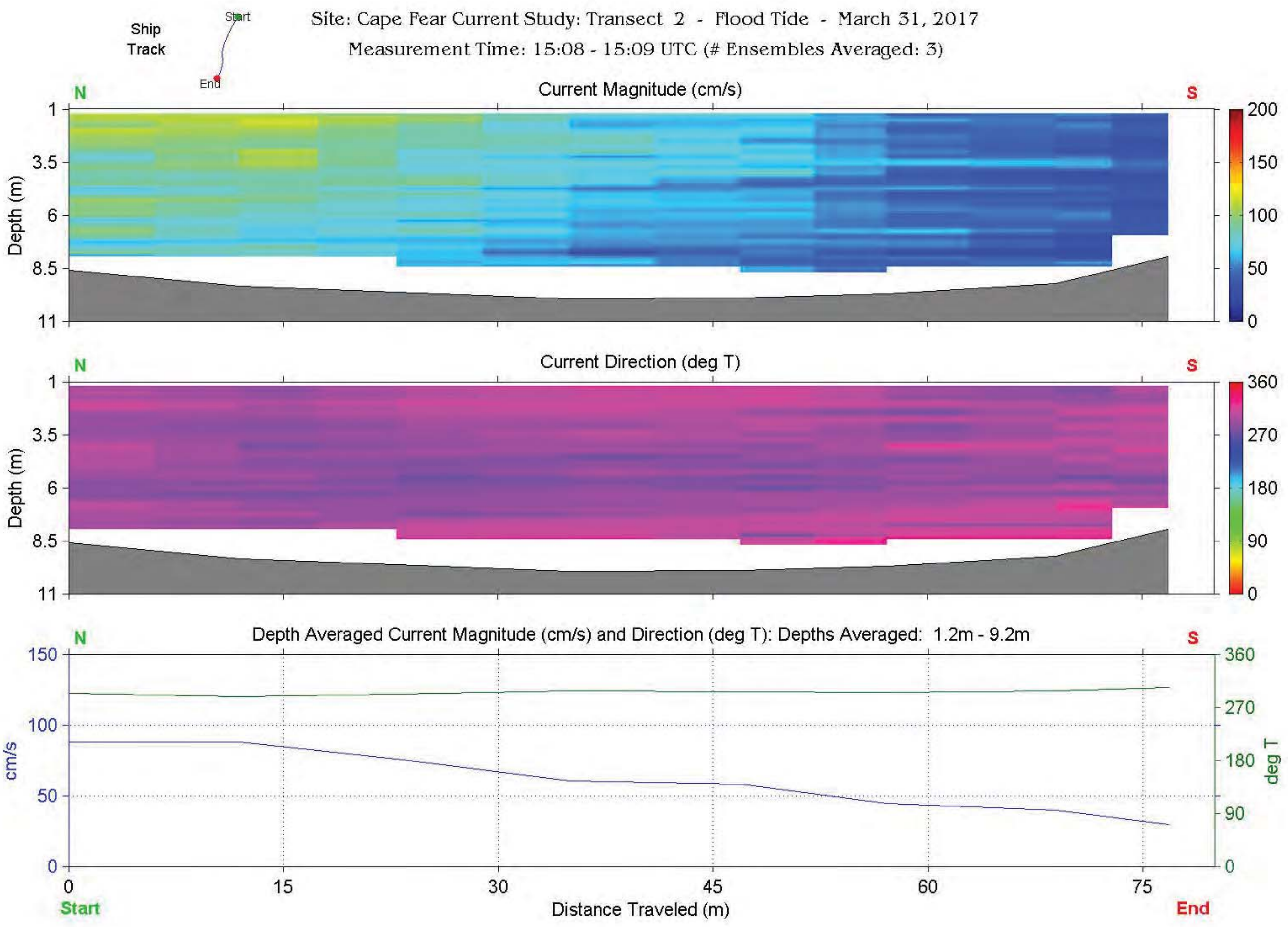

Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 31, 2017

Measurement Time: 14:46 - 14:46 UTC (# Ensembles Averaged: 3)

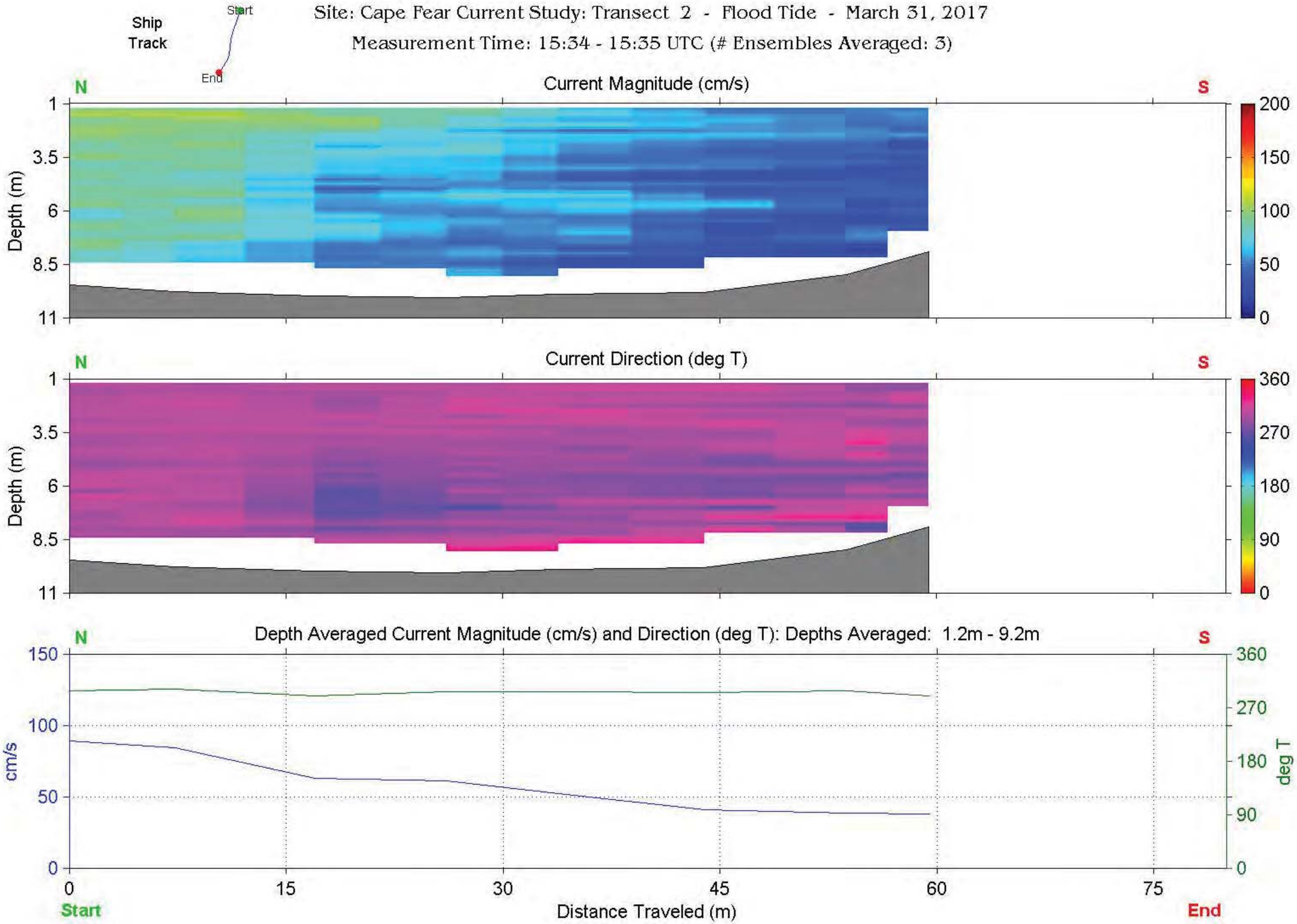
Current Magnitude (cm/s)

Current Direction (deg T)

Depth Averaged Current Magnitude (cm/s) and Direction (deg T): Depths Averaged: 1.2m - 9m


Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 31, 2017

Measurement Time: 15:08 - 15:09 UTC (# Ensembles Averaged: 3)

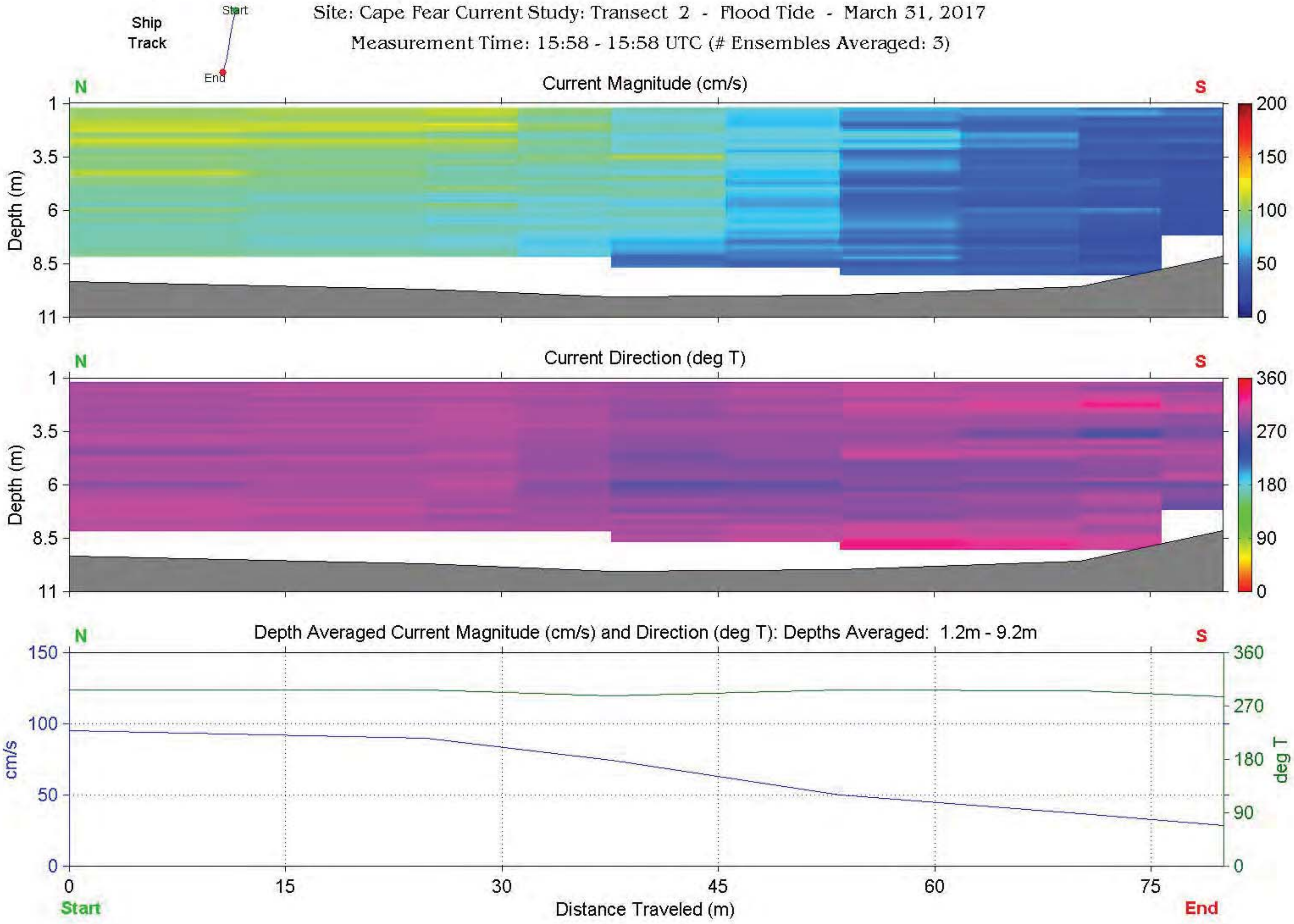


Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 31, 2017

Measurement Time: 15:34 - 15:35 UTC (# Ensembles Averaged: 3)

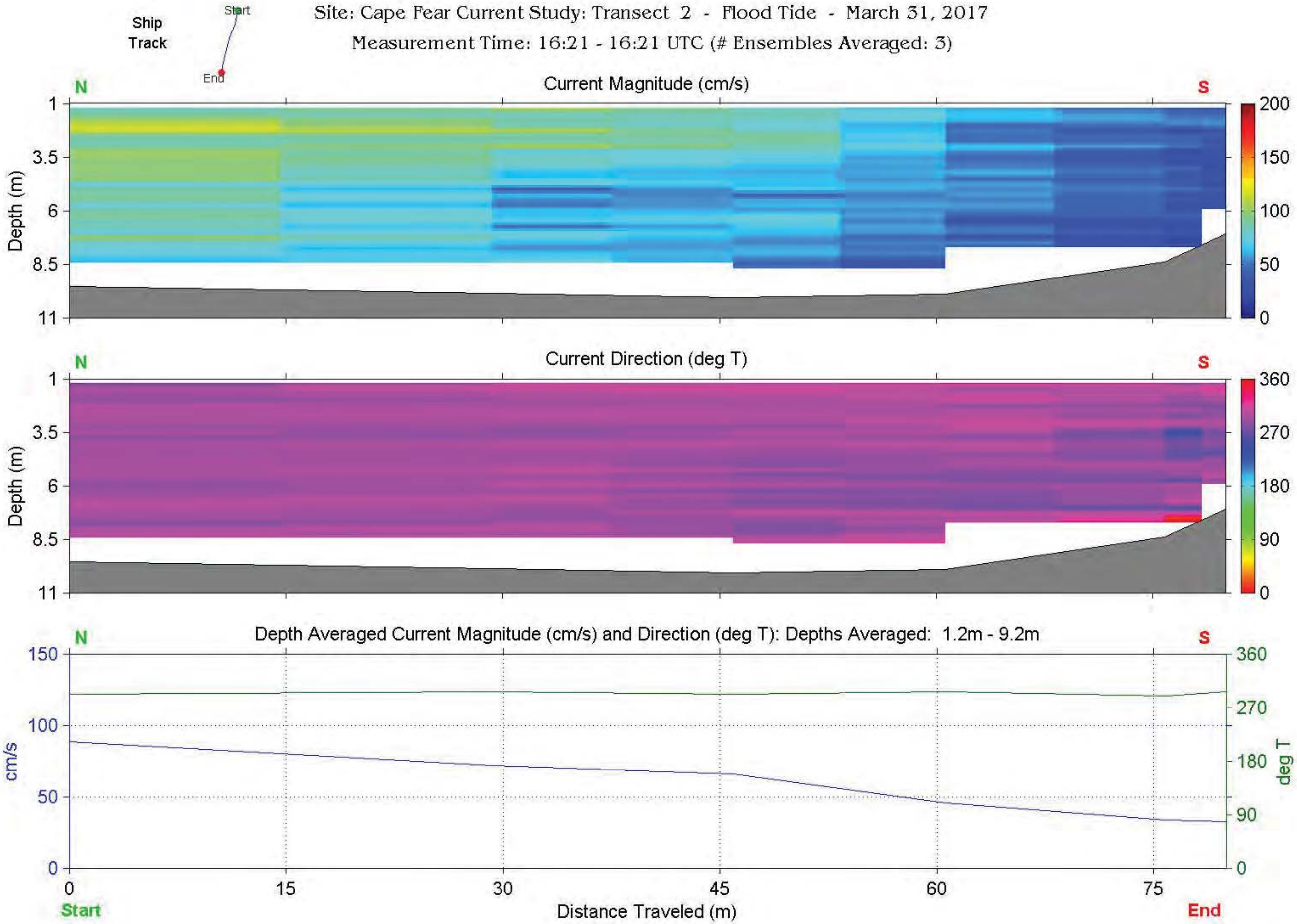
Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 31, 2017

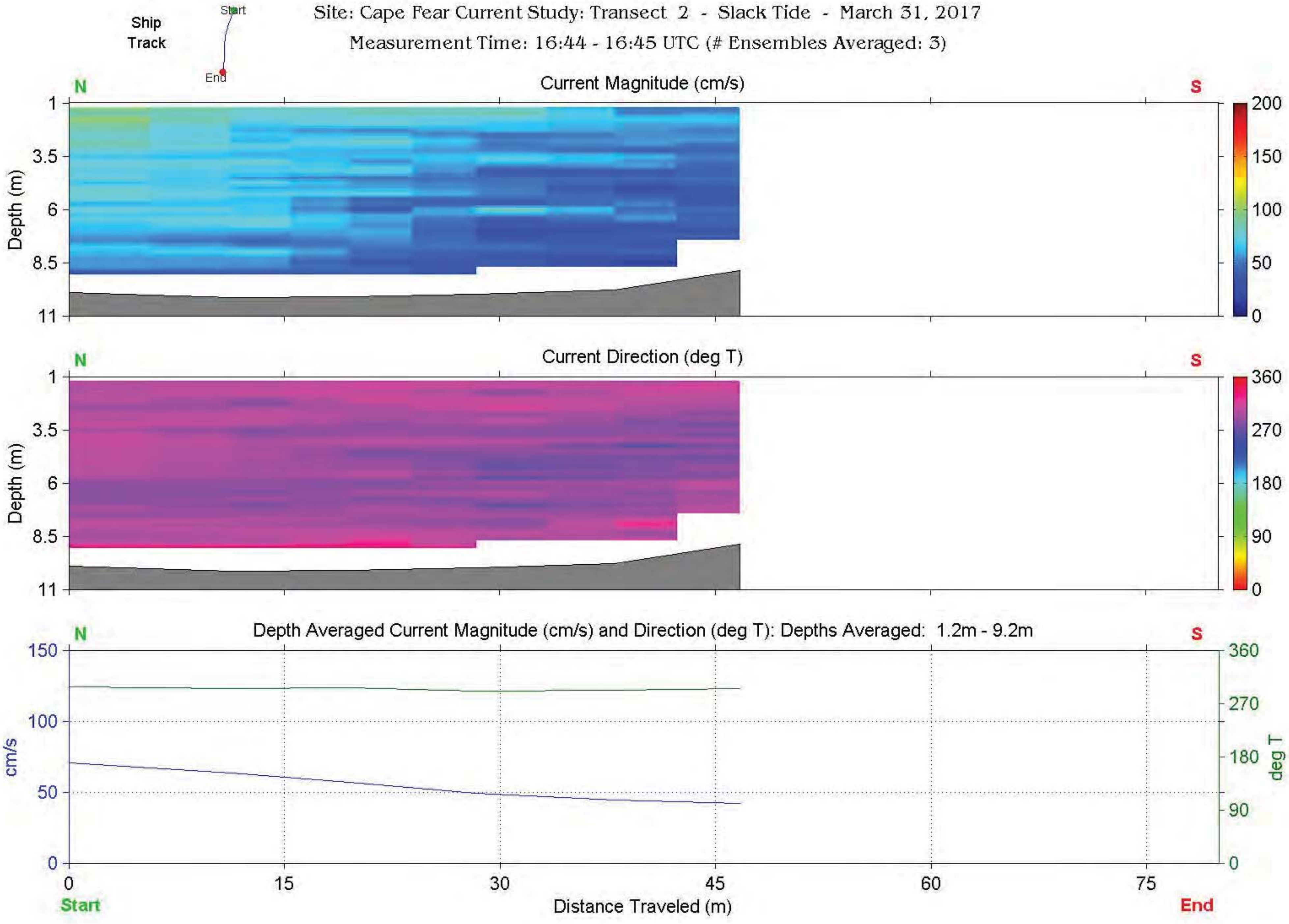
Measurement Time: 15:58 - 15:58 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 2 - Flood Tide - March 31, 2017

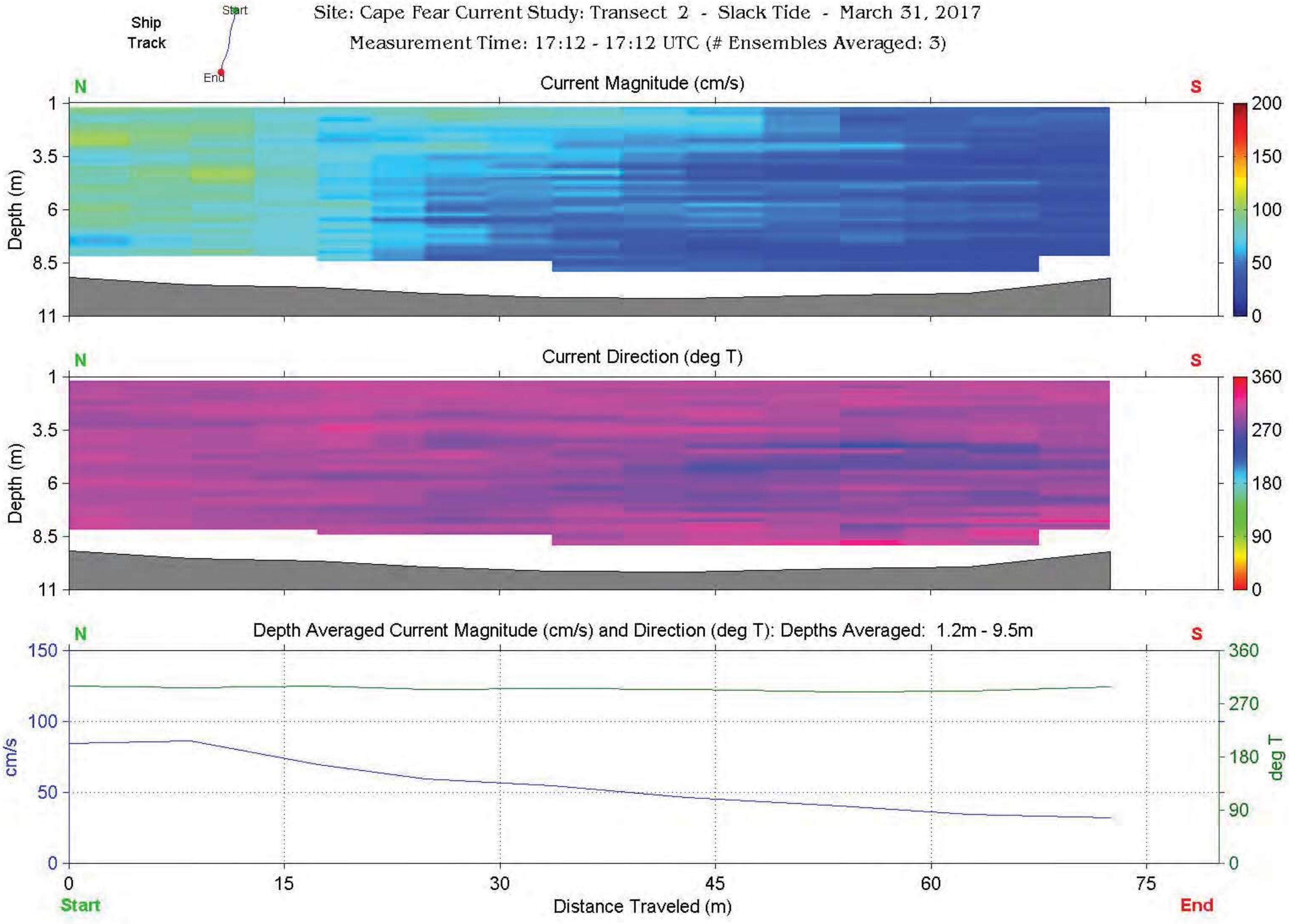
Measurement Time: 16:21 - 16:21 UTC (# Ensembles Averaged: 3)





Site: Cape Fear Current Study: Transect 2 - Slack Tide - March 31, 2017

Measurement Time: 16:44 - 16:45 UTC (# Ensembles Averaged: 3)

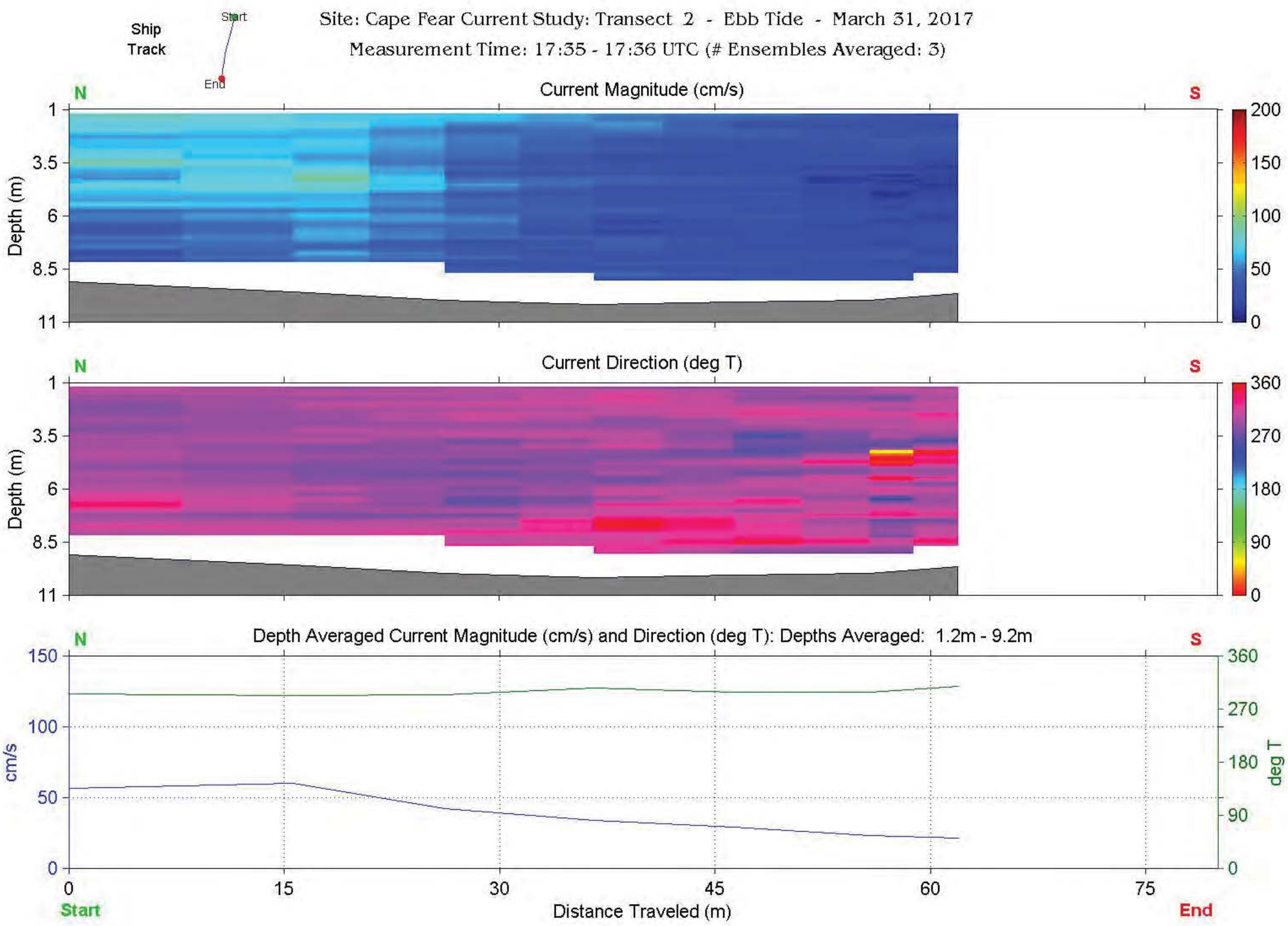


Site: Cape Fear Current Study: Transect 2 - Slack Tide - March 31, 2017

Measurement Time: 17:12 - 17:12 UTC (# Ensembles Averaged: 3)

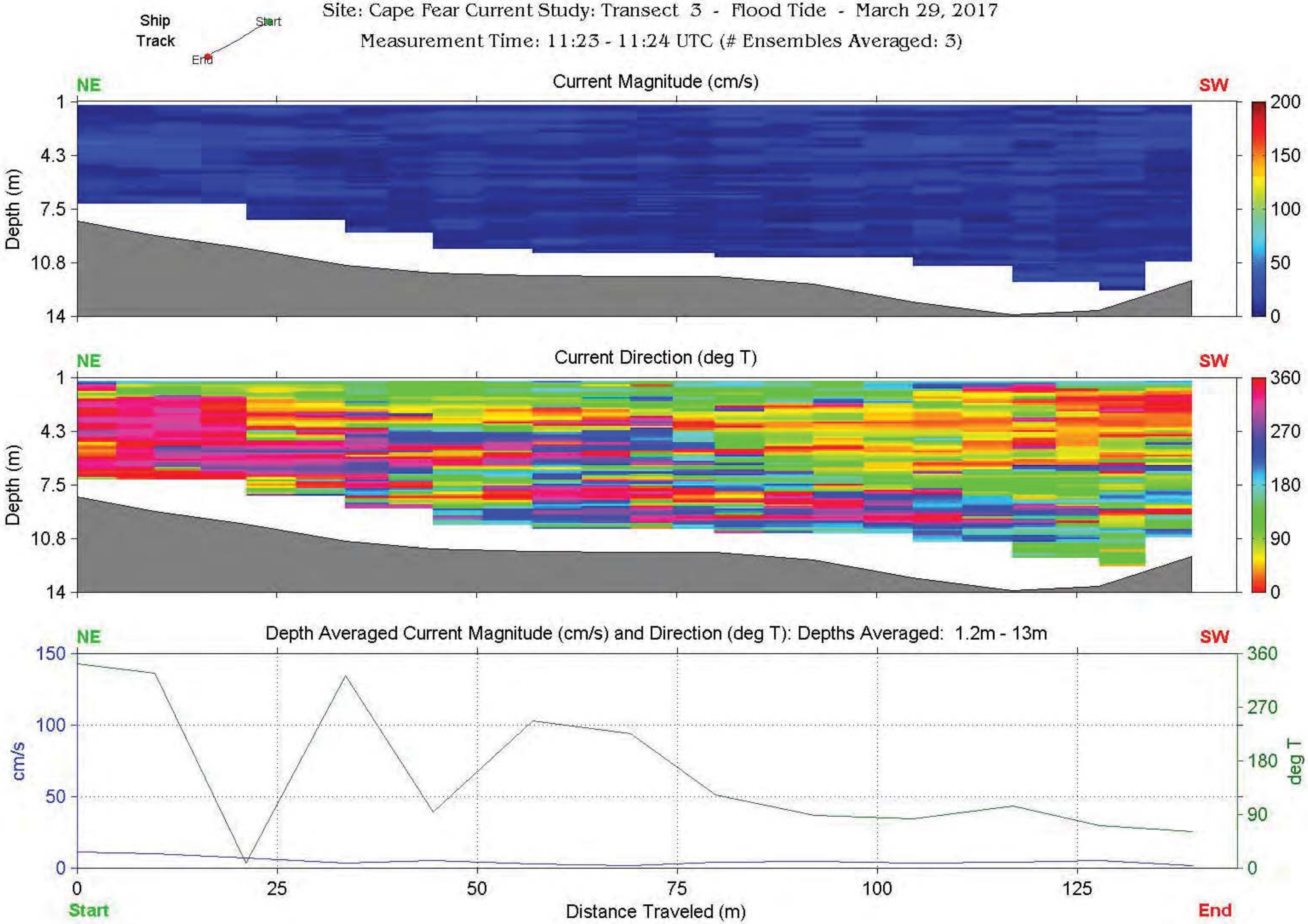
Site: Cape Fear Current Study: Transect 2 - Ebb Tide - March 31, 2017

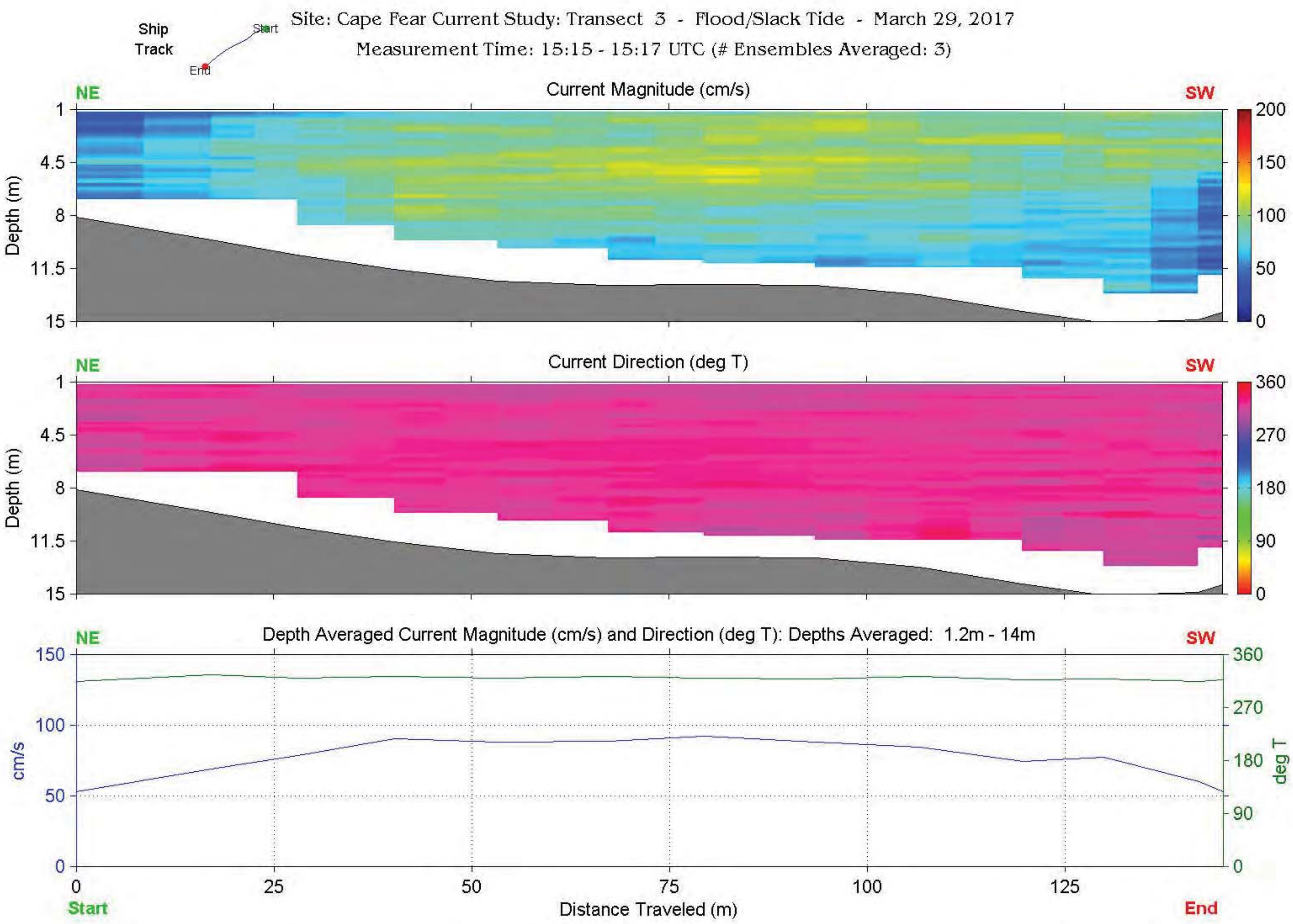
Measurement Time: 17:35 - 17:36 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 29, 2017

Measurement Time: 11:23 - 11:24 UTC (# Ensembles Averaged: 3)

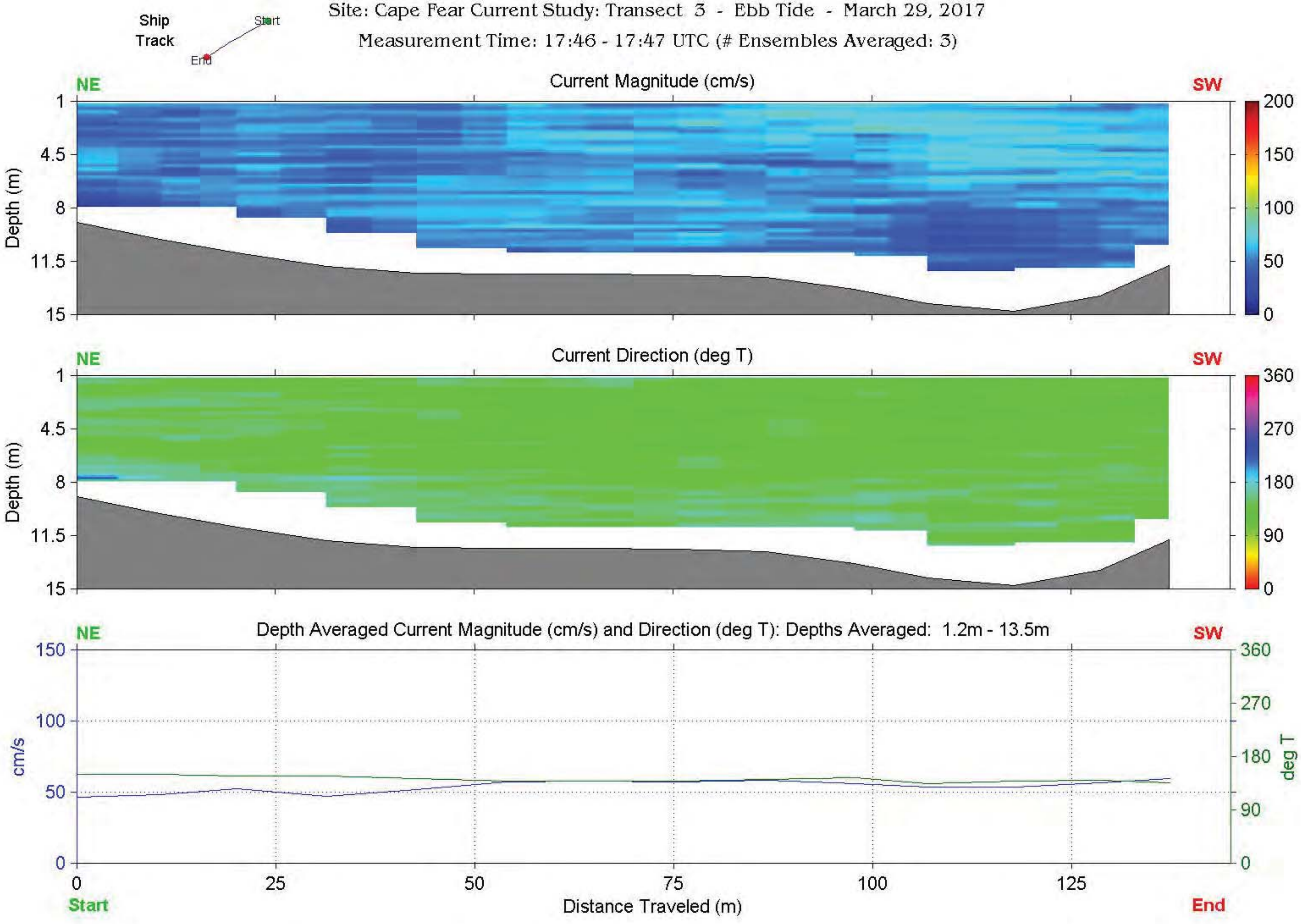



Site: Cape Fear Current Study: Transect 3 - Flood/Slack Tide - March 29, 2017

Measurement Time: 15:15 - 15:17 UTC (# Ensembles Averaged: 3)

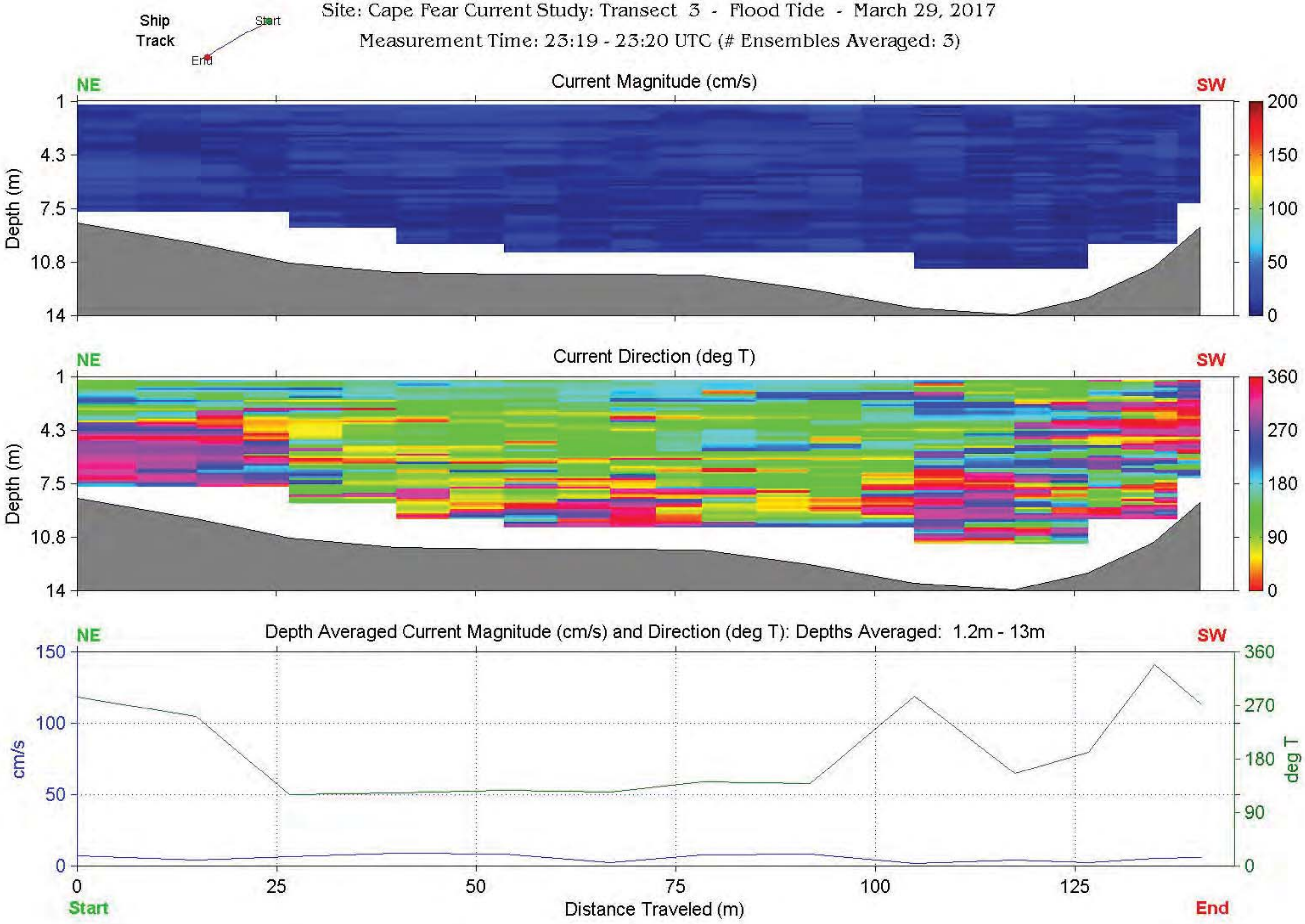
Site: Cape Fear Current Study: Transect 3 - Ebb Tide - March 29, 2017

Measurement Time: 17:46 - 17:47 UTC (# Ensembles Averaged: 3)



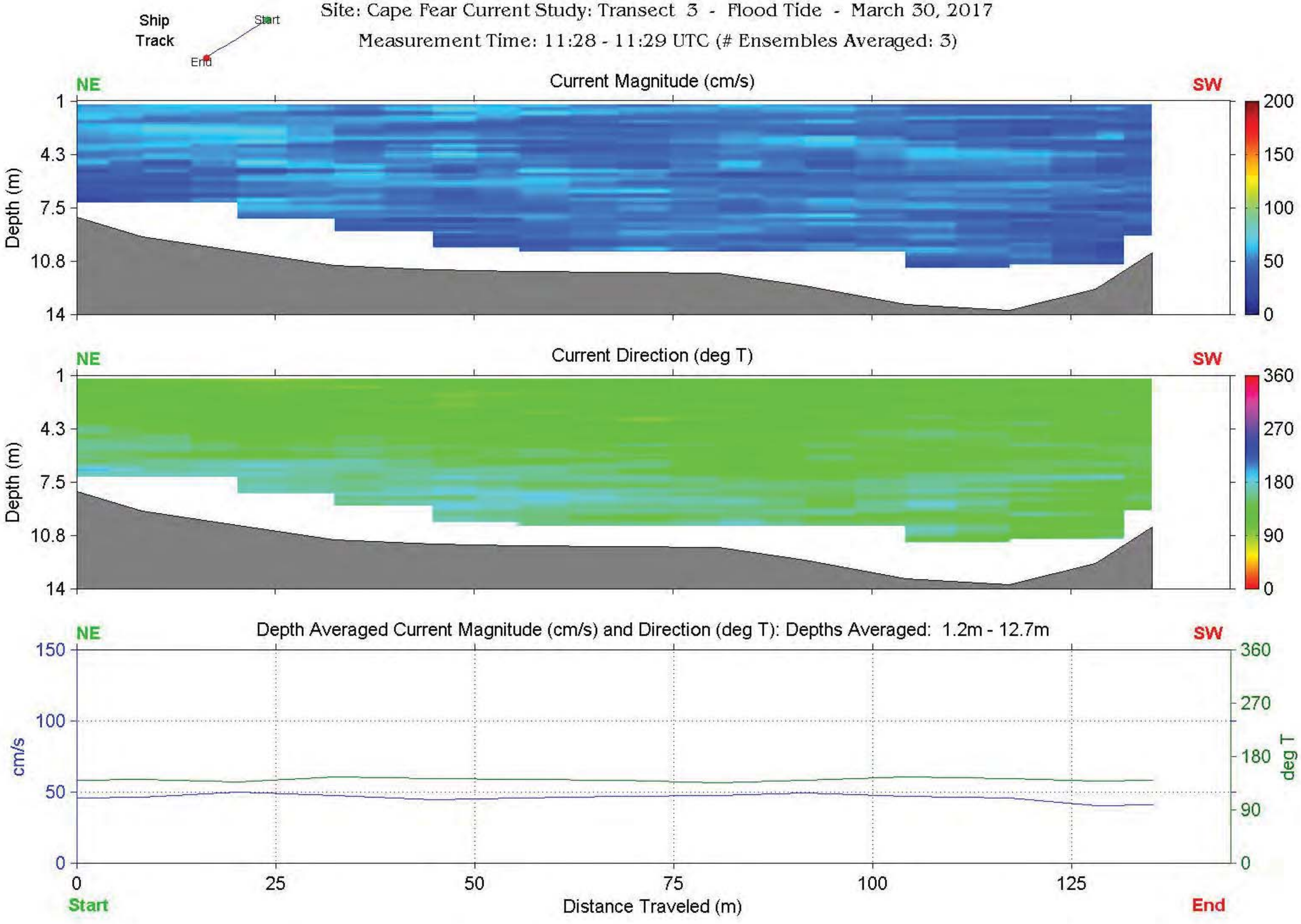
Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 29, 2017

Measurement Time: 23:19 - 23:20 UTC (# Ensembles Averaged: 3)



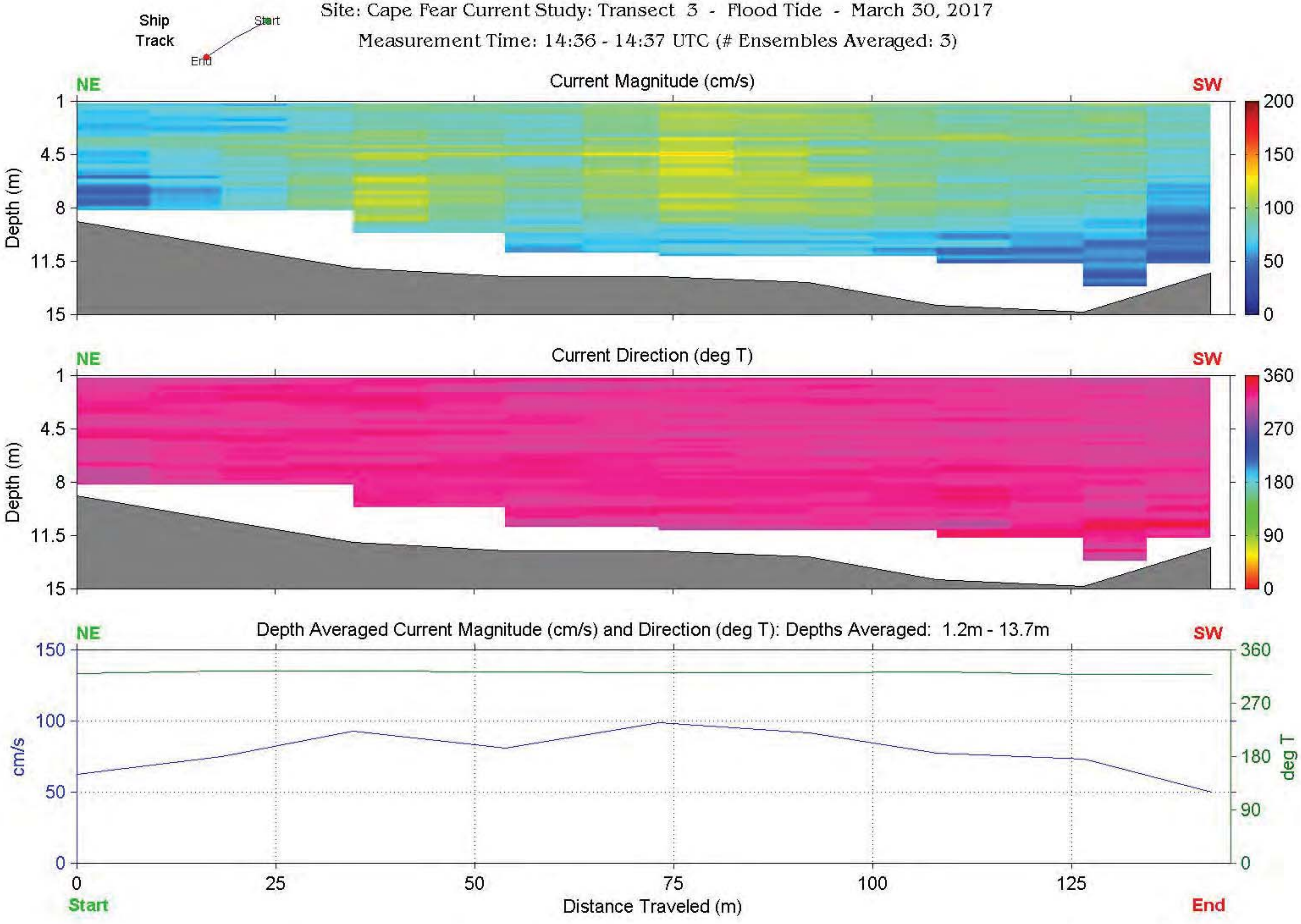
Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 30, 2017

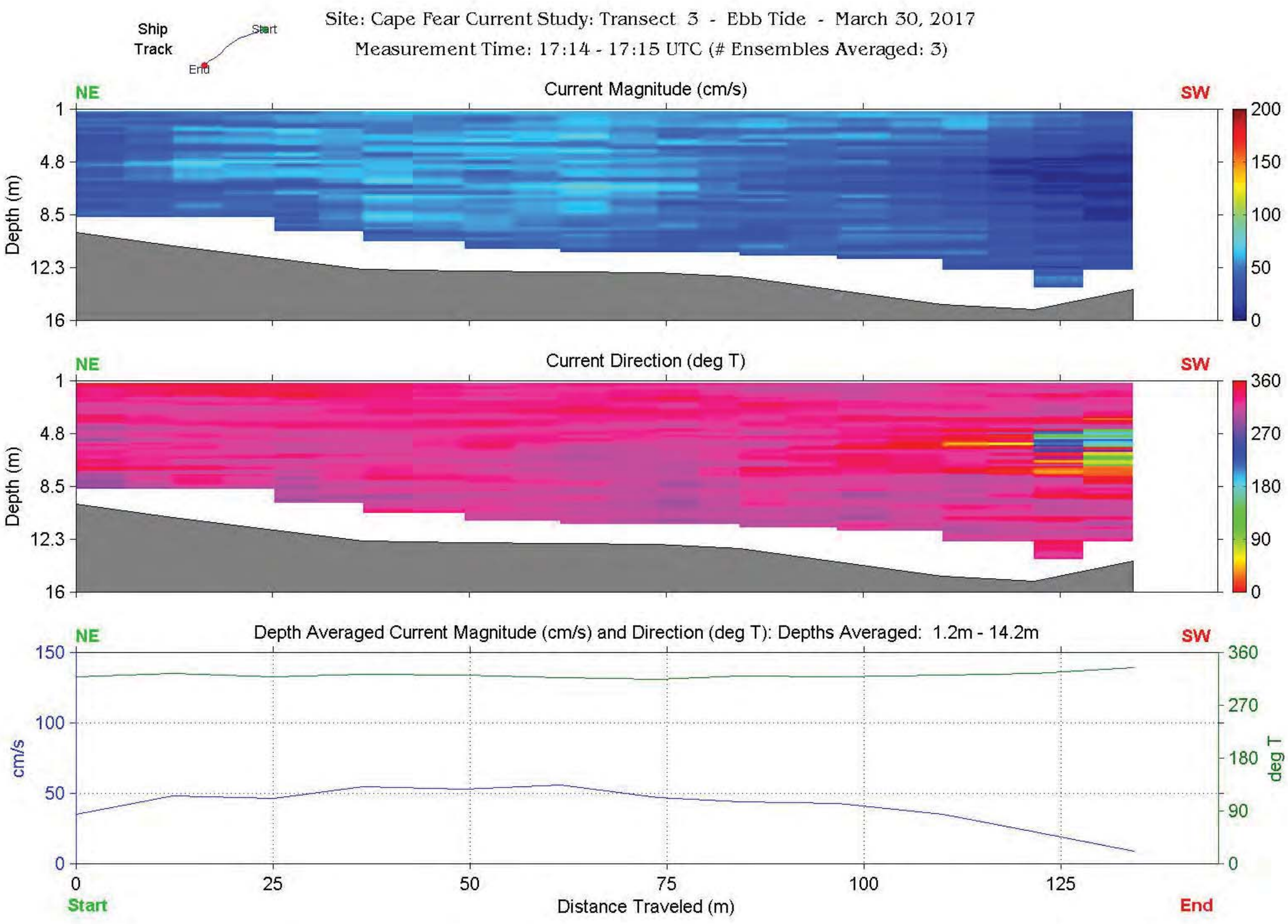
Measurement Time: 11:28 - 11:29 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 30, 2017

Measurement Time: 14:36 - 14:37 UTC (# Ensembles Averaged: 3)



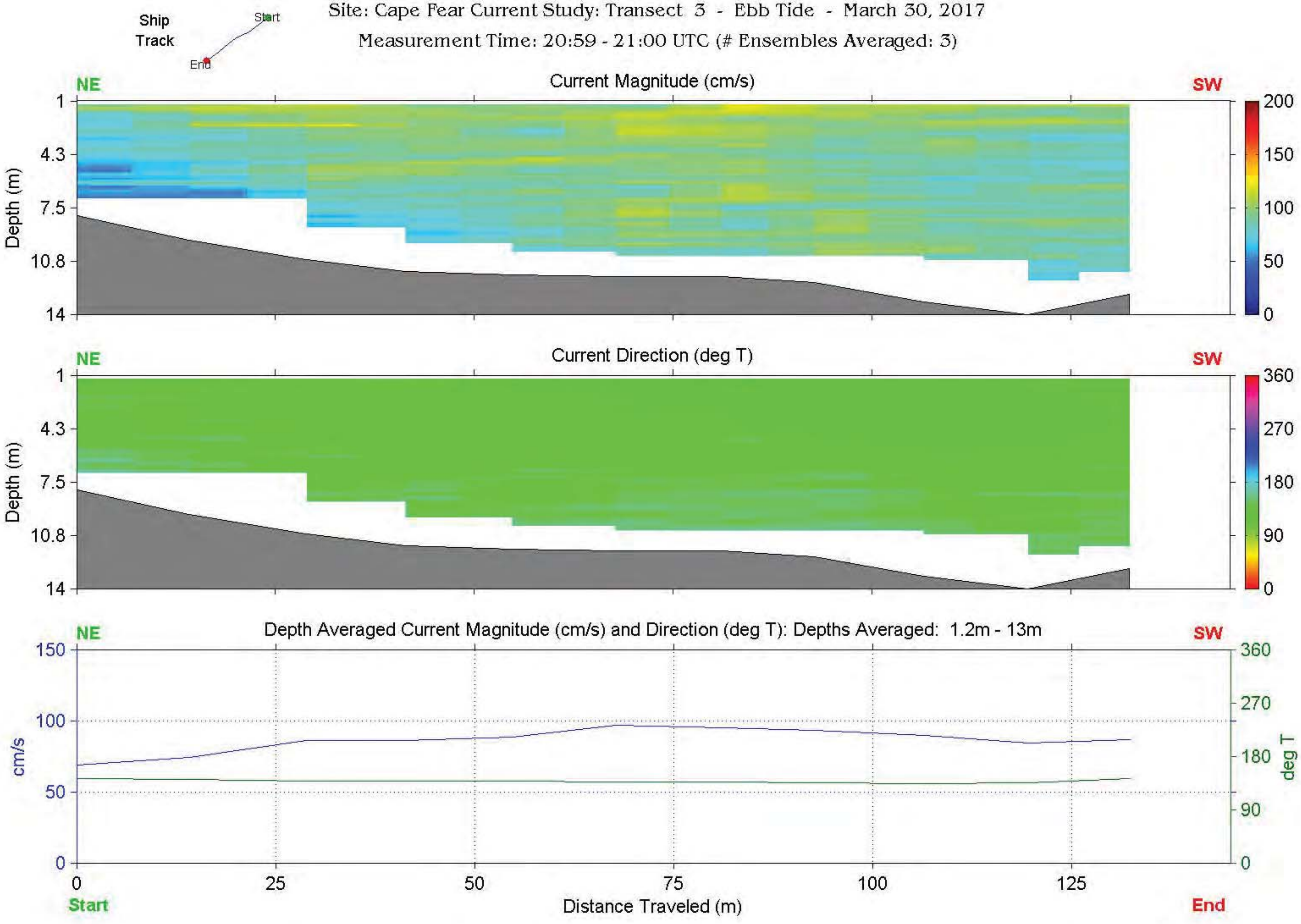


Site: Cape Fear Current Study: Transect 3 - Ebb Tide - March 30, 2017

Measurement Time: 17:14 - 17:15 UTC (# Ensembles Averaged: 3)

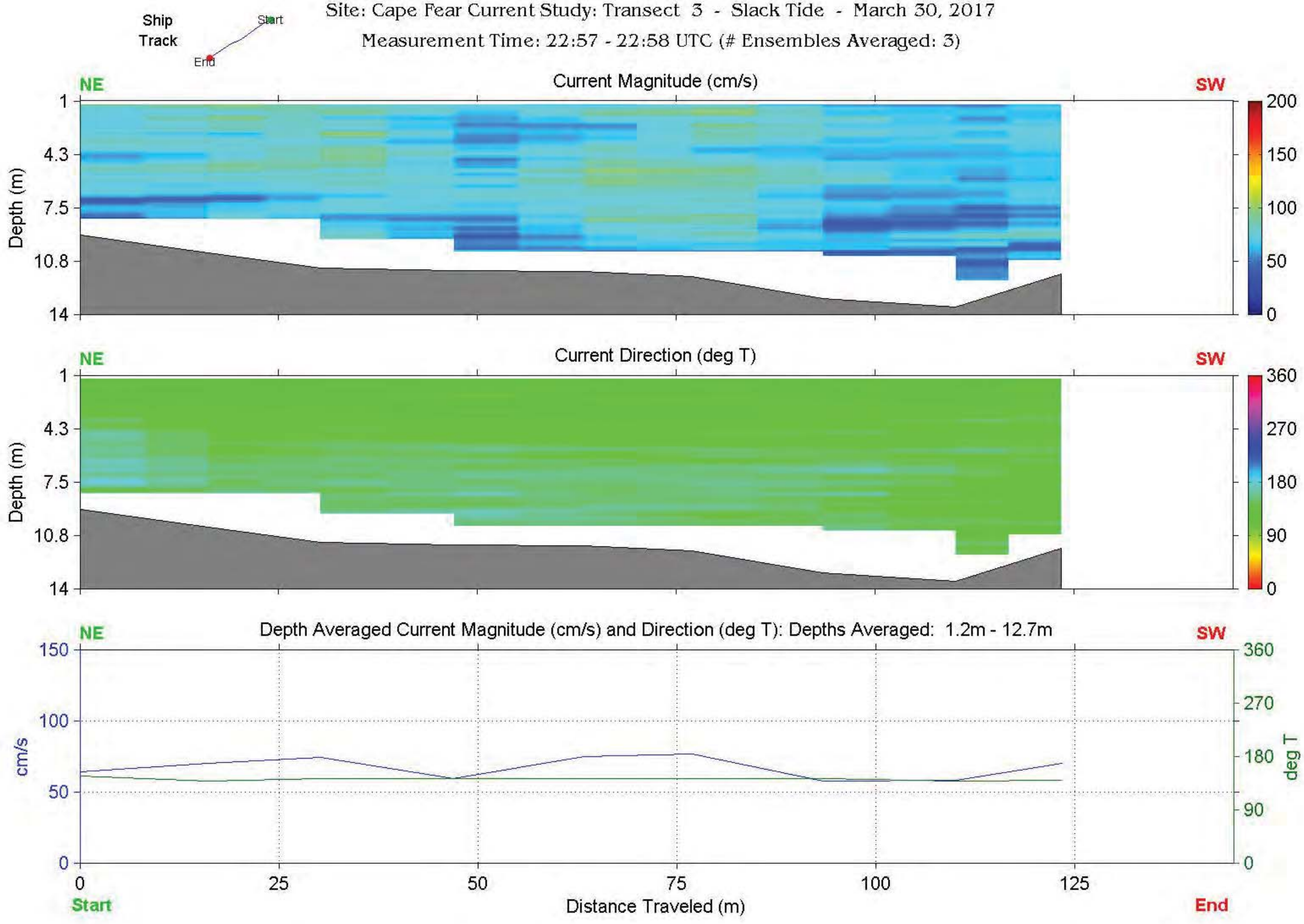
Site: Cape Fear Current Study: Transect 3 - Ebb Tide - March 30, 2017

Measurement Time: 20:59 - 21:00 UTC (# Ensembles Averaged: 3)



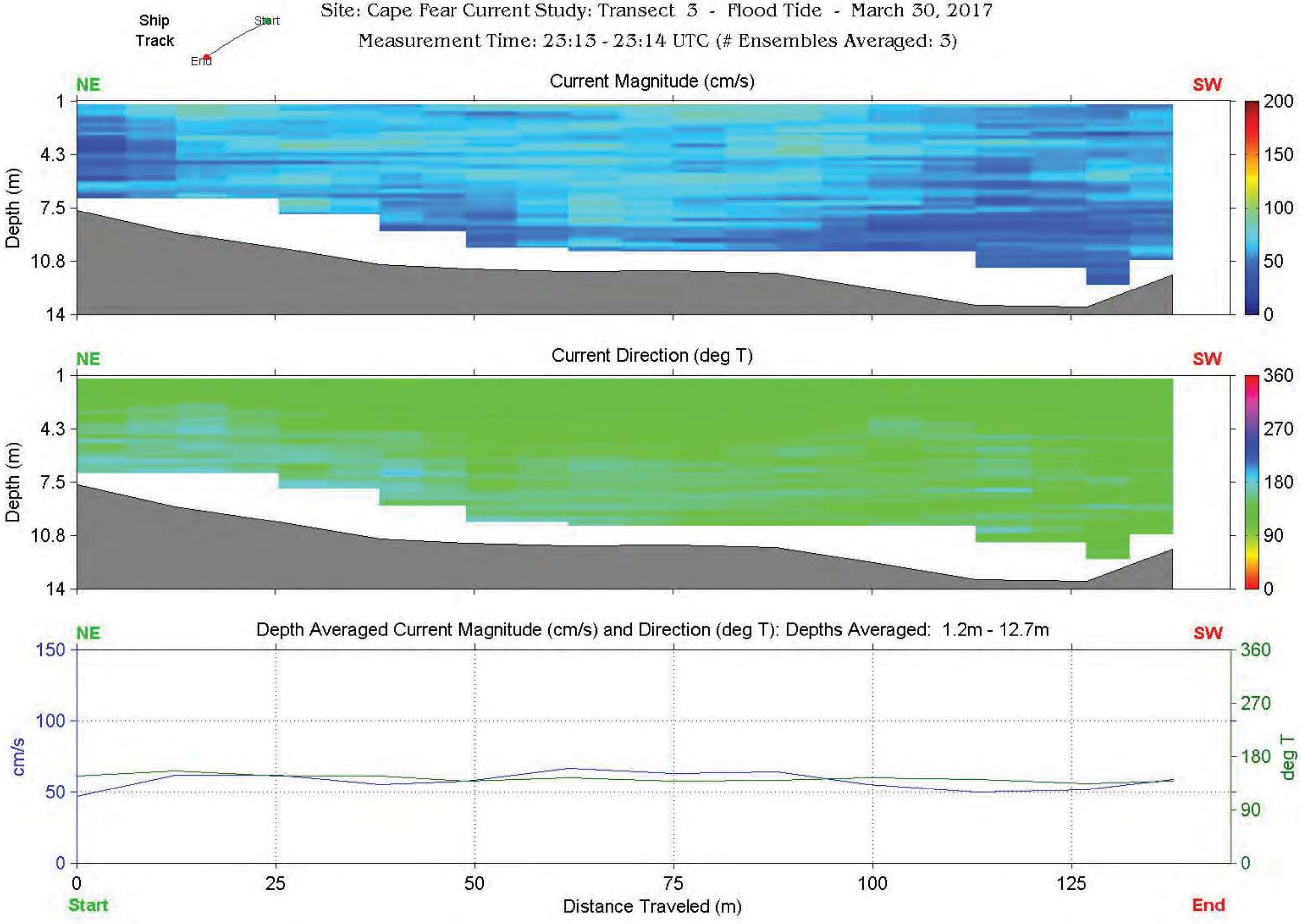
Site: Cape Fear Current Study: Transect 3 - Slack Tide - March 30, 2017

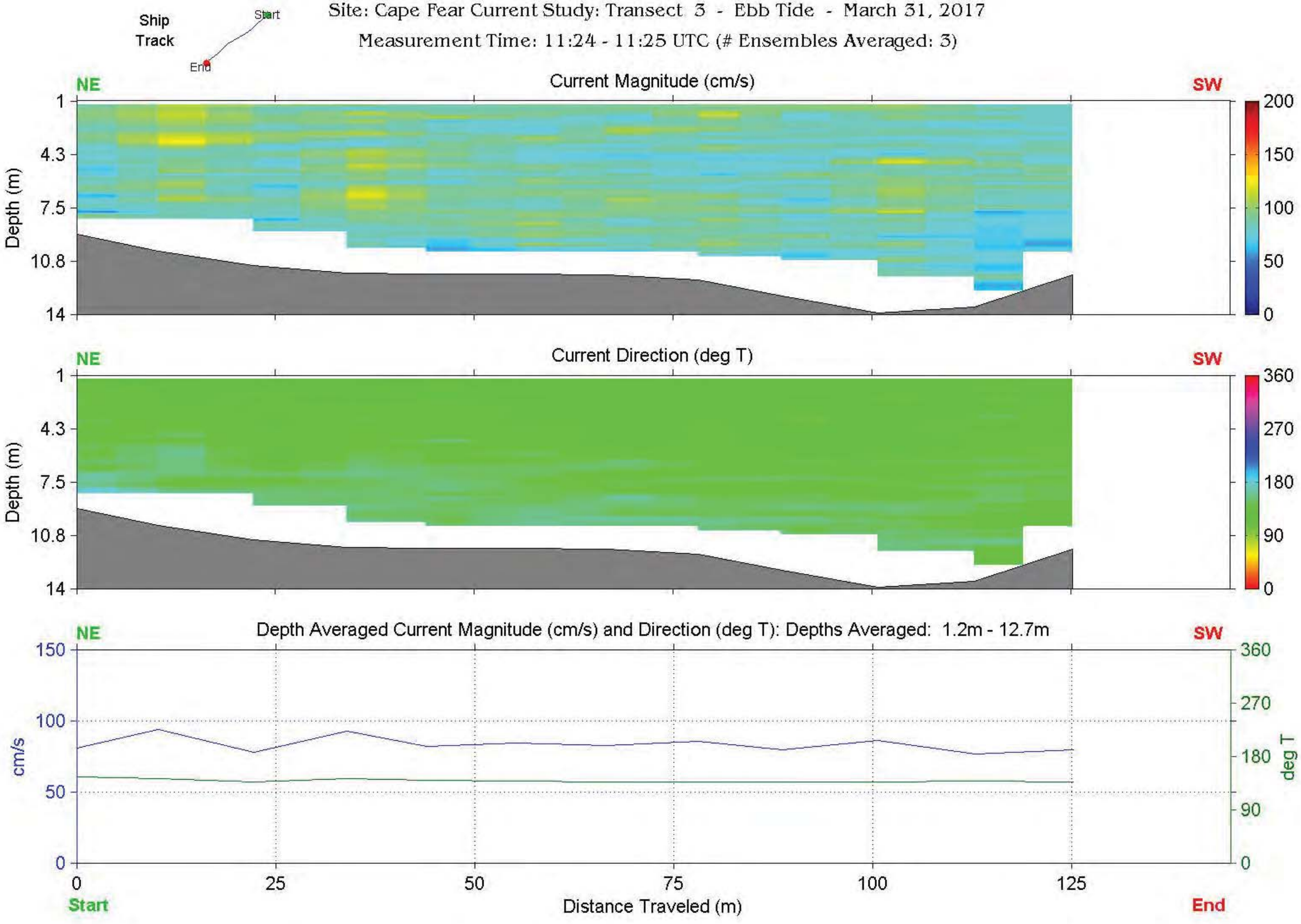
Measurement Time: 22:57 - 22:58 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 30, 2017

Measurement Time: 23:13 - 23:14 UTC (# Ensembles Averaged: 3)



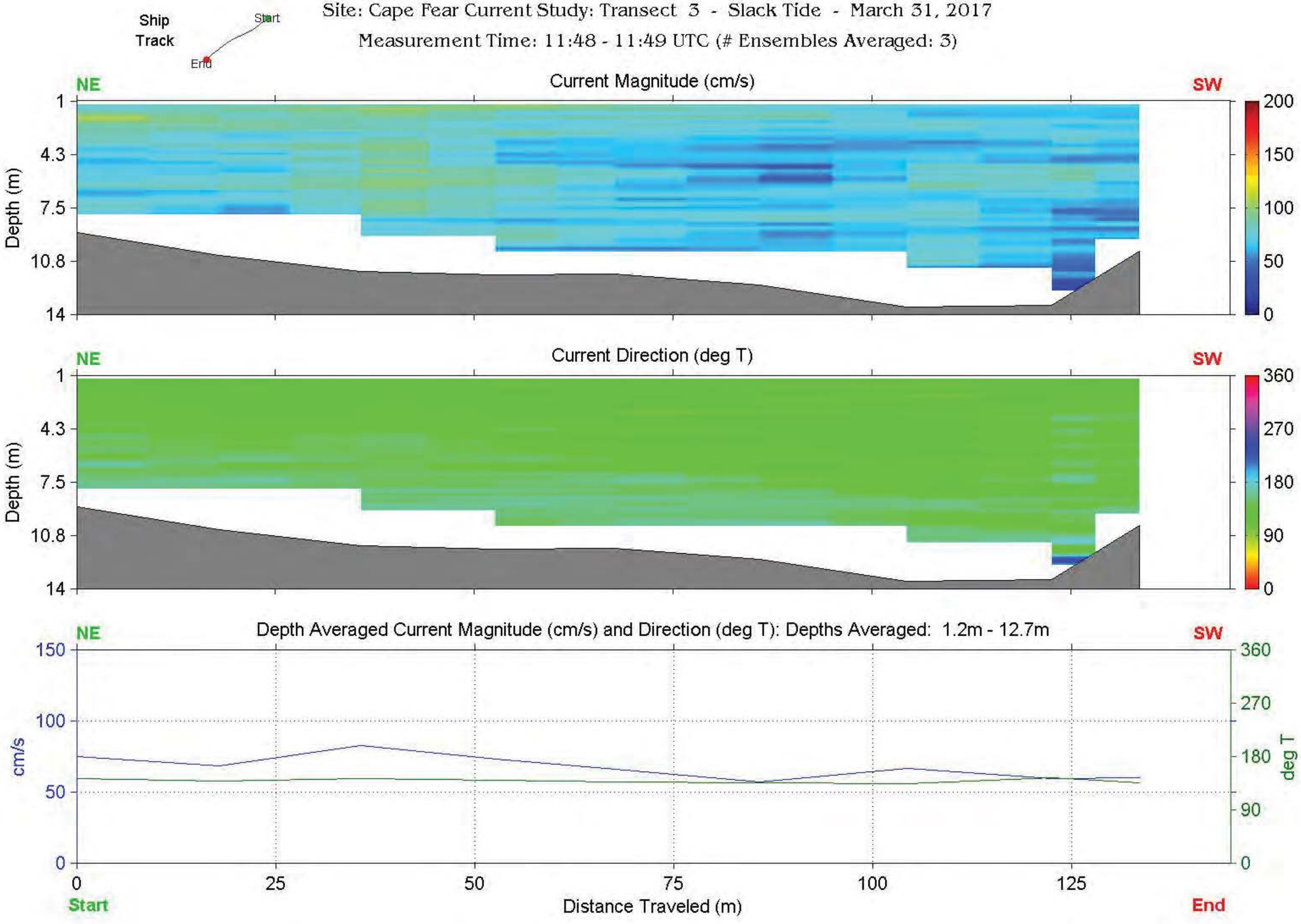


Site: Cape Fear Current Study: Transect 3 - Ebb Tide - March 31, 2017

Measurement Time: 11:24 - 11:25 UTC (# Ensembles Averaged: 3)

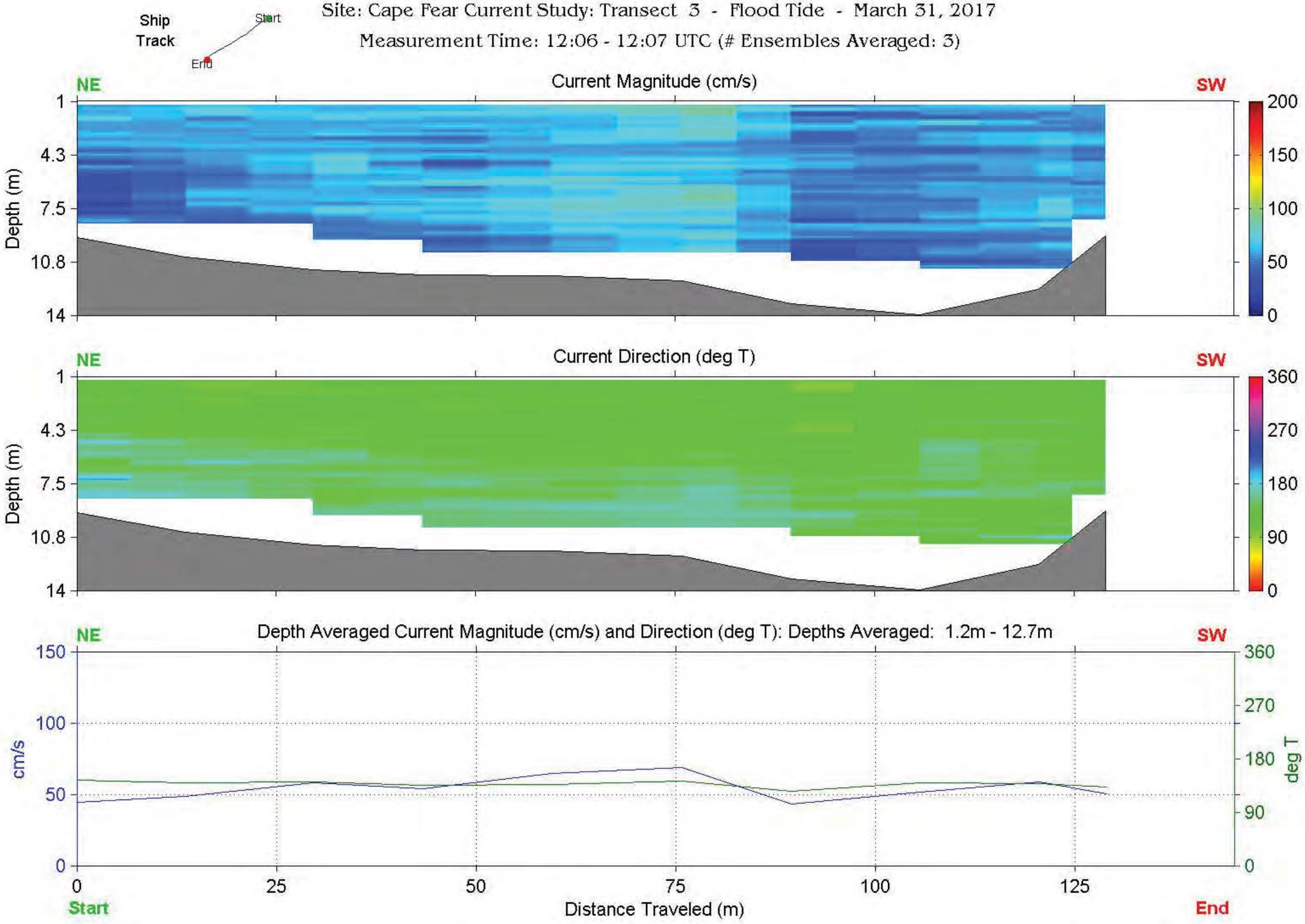
Site: Cape Fear Current Study: Transect 3 - Slack Tide - March 31, 2017

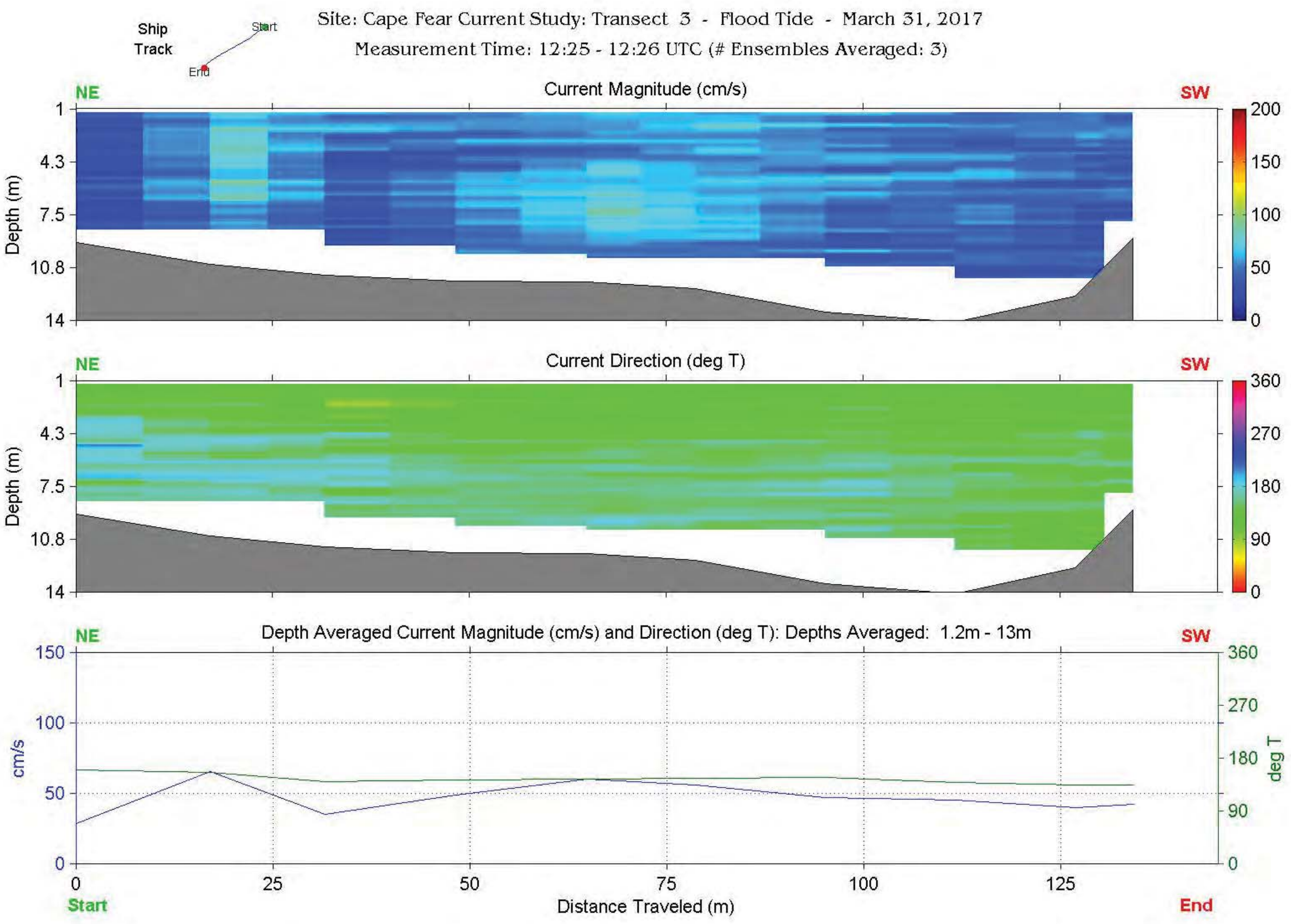
Measurement Time: 11:48 - 11:49 UTC (# Ensembles Averaged: 3)



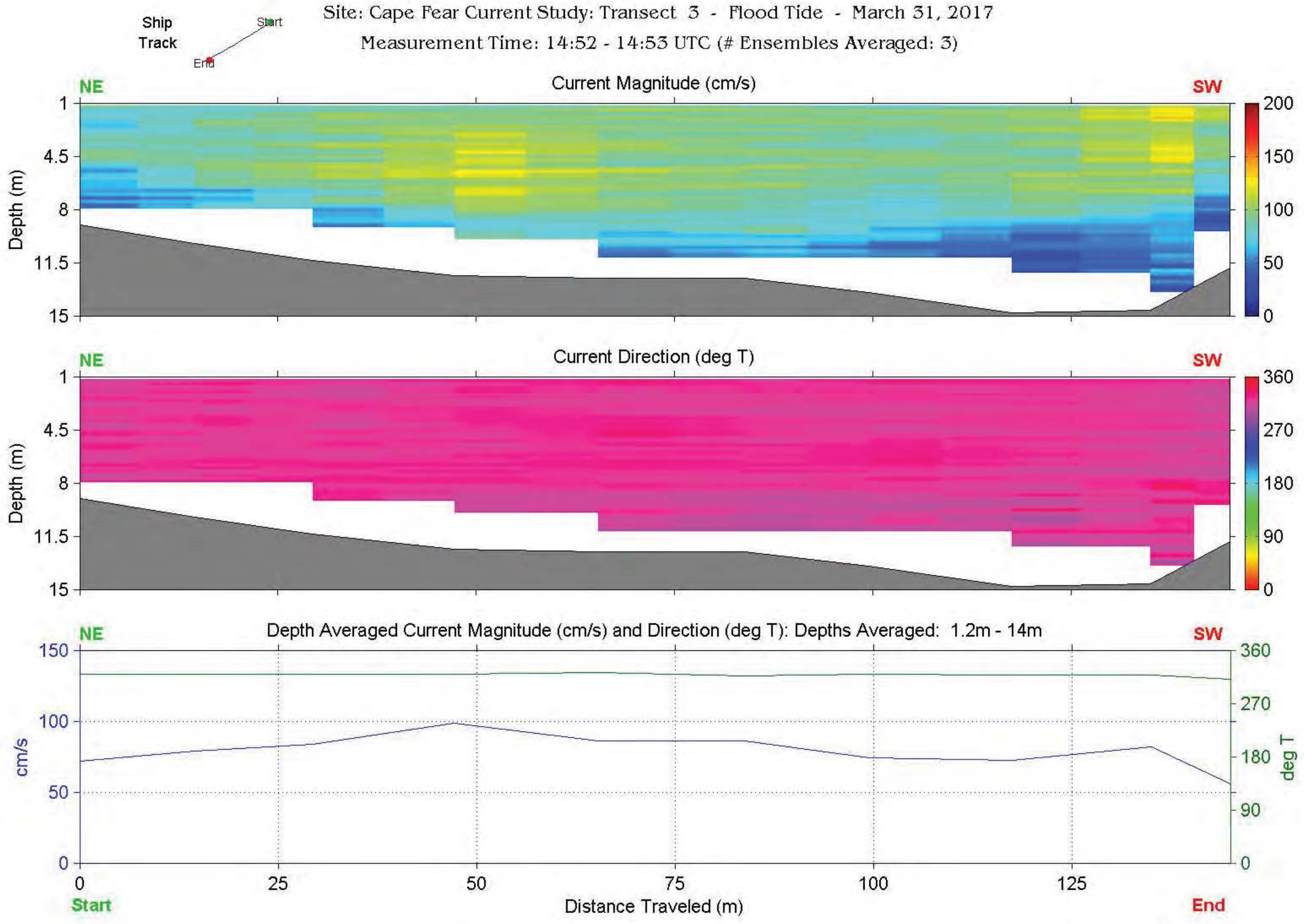
Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

Measurement Time: 12:06 - 12:07 UTC (# Ensembles Averaged: 3)



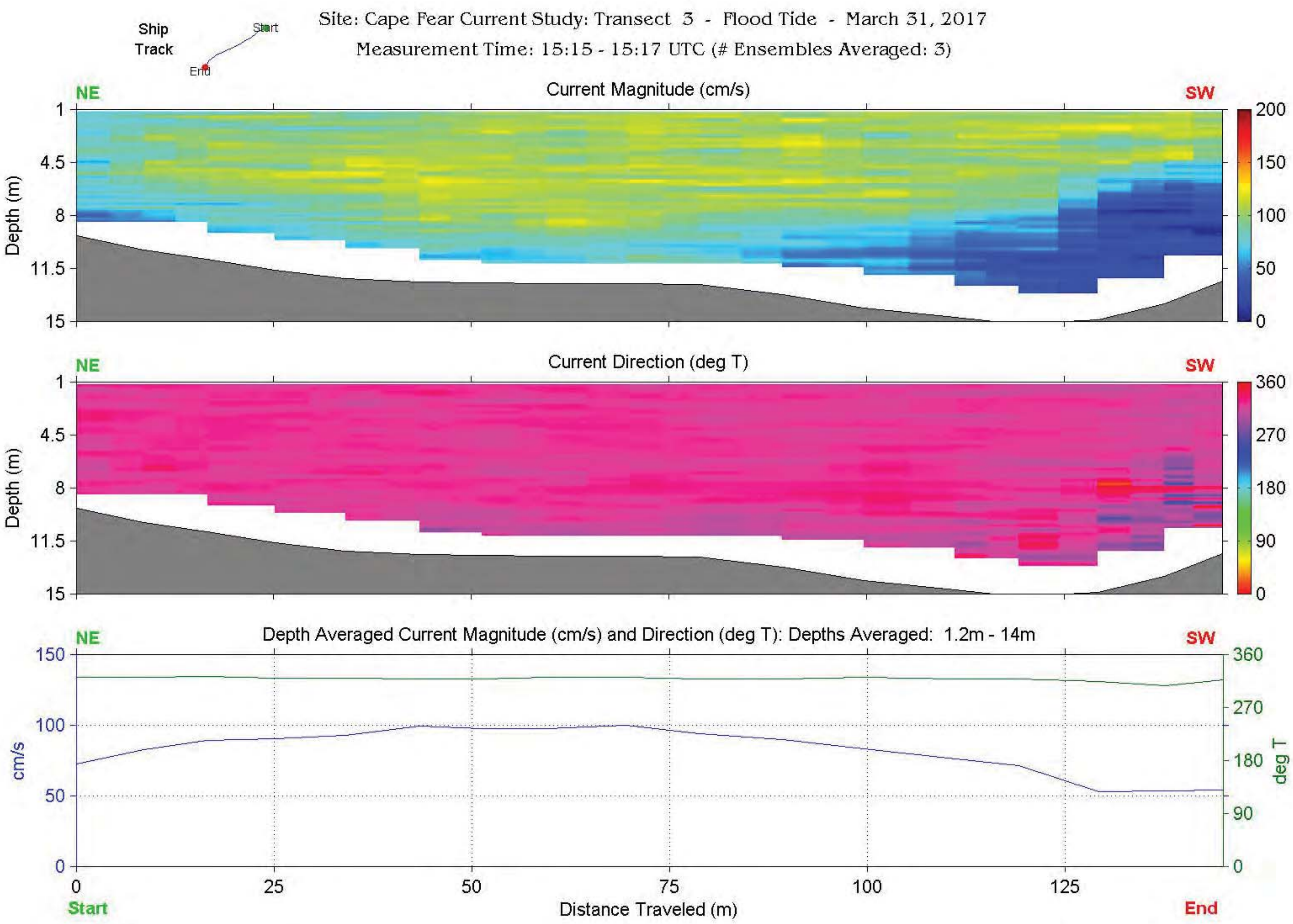

Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

Measurement Time: 12:25 - 12:26 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

Measurement Time: 14:52 - 14:53 UTC (# Ensembles Averaged: 3)

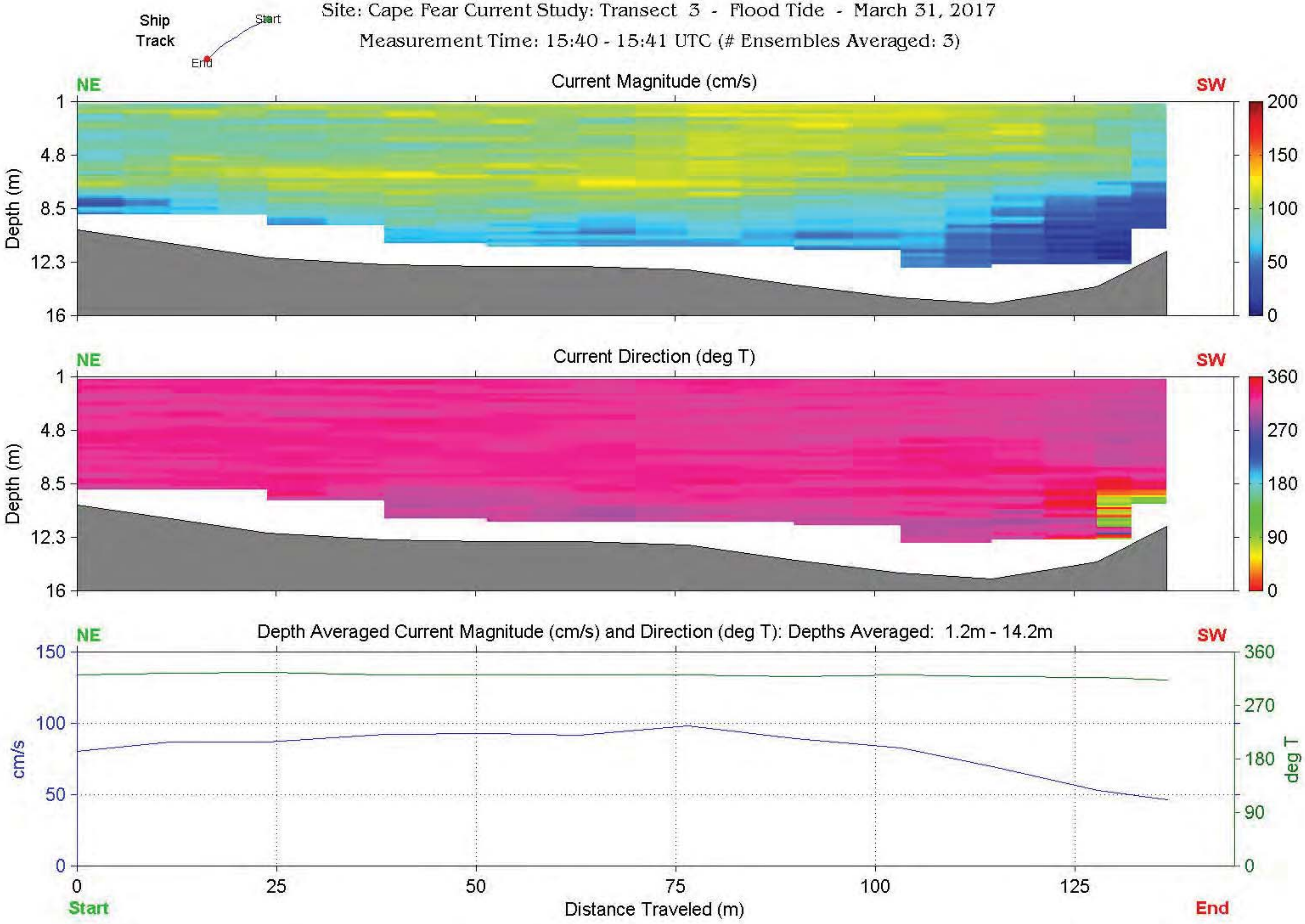


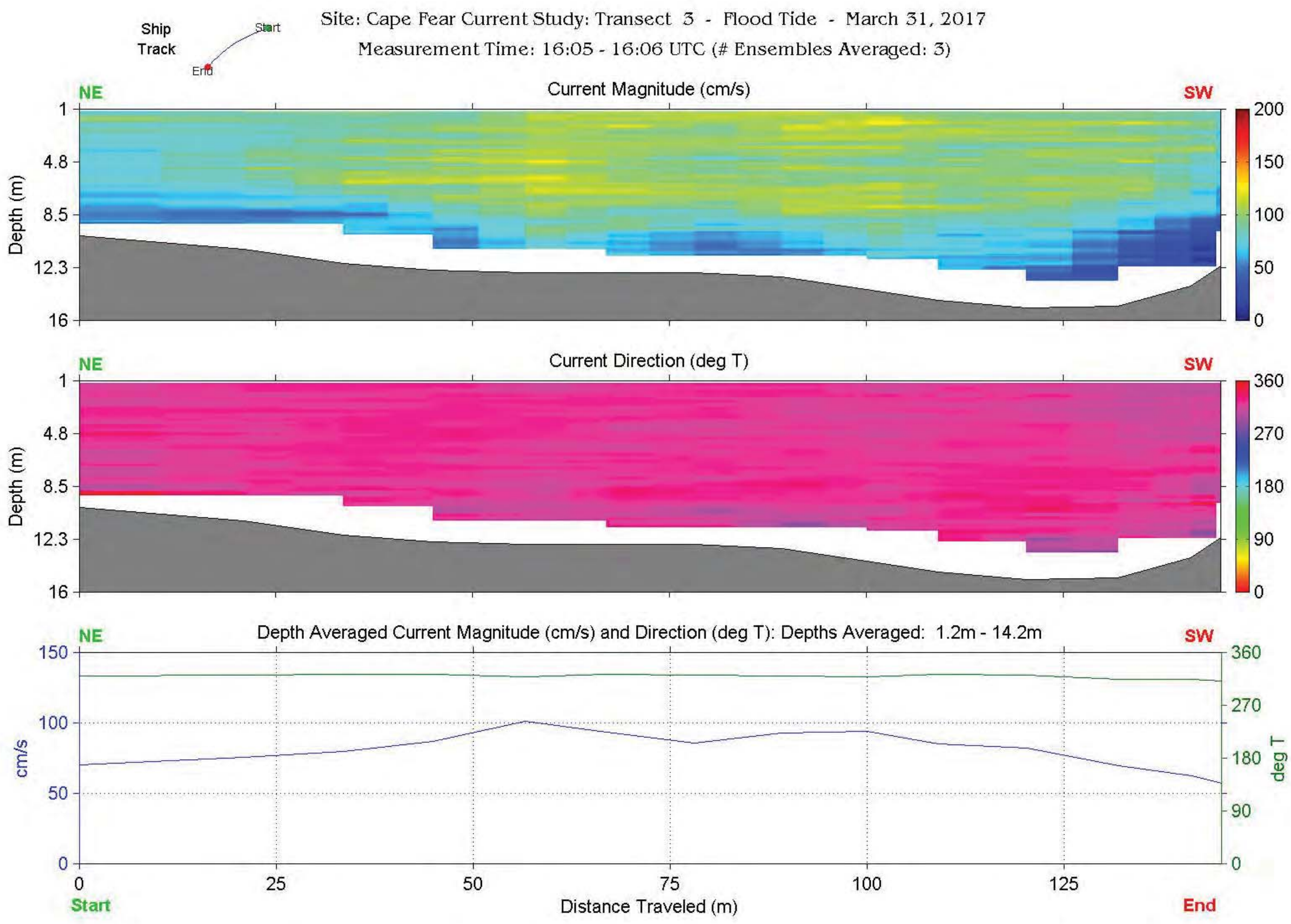
Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

Measurement Time: 15:15 - 15:17 UTC (# Ensembles Averaged: 3)

Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

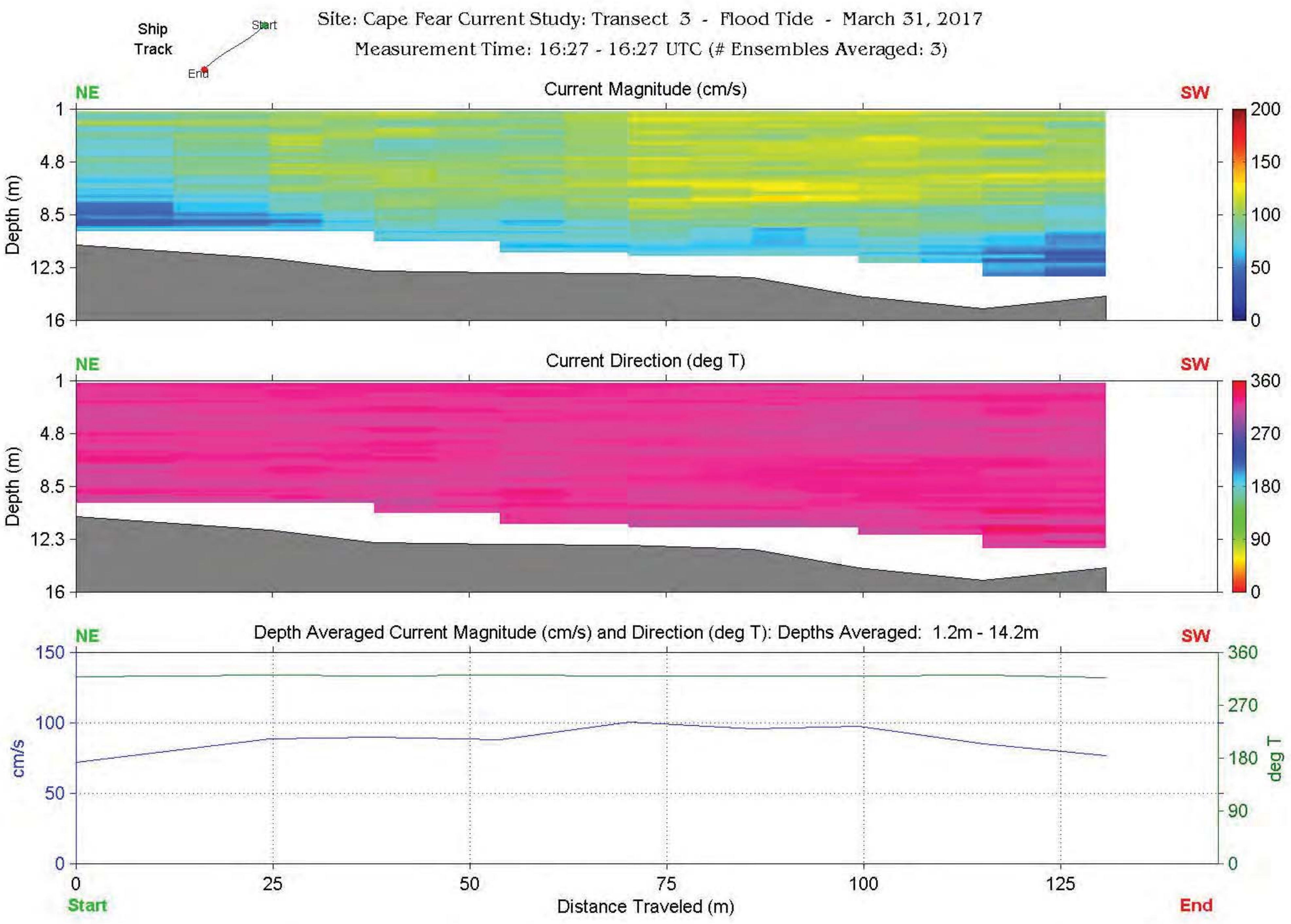
Measurement Time: 15:40 - 15:41 UTC (# Ensembles Averaged: 3)



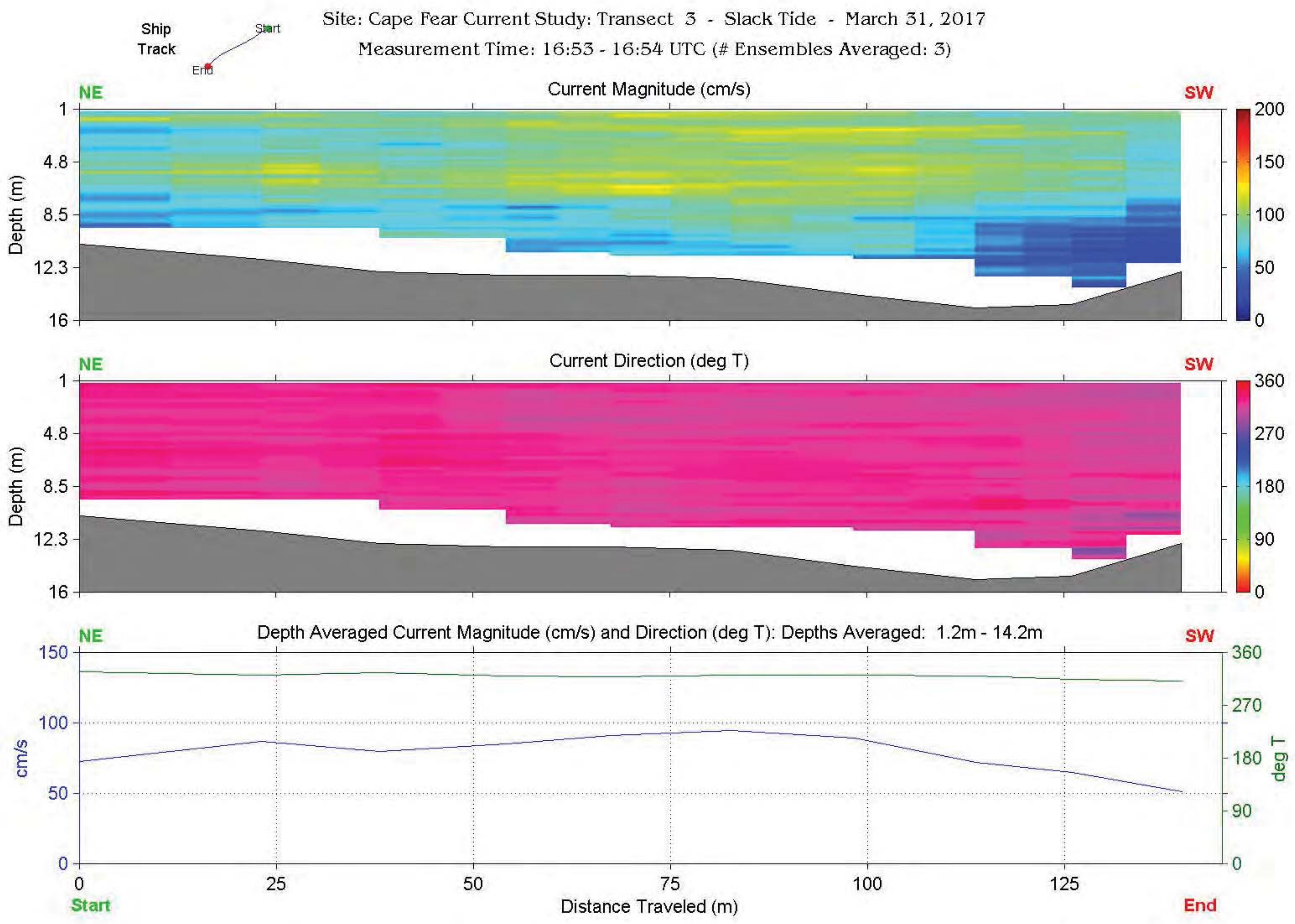


Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

Measurement Time: 16:05 - 16:06 UTC (# Ensembles Averaged: 3)

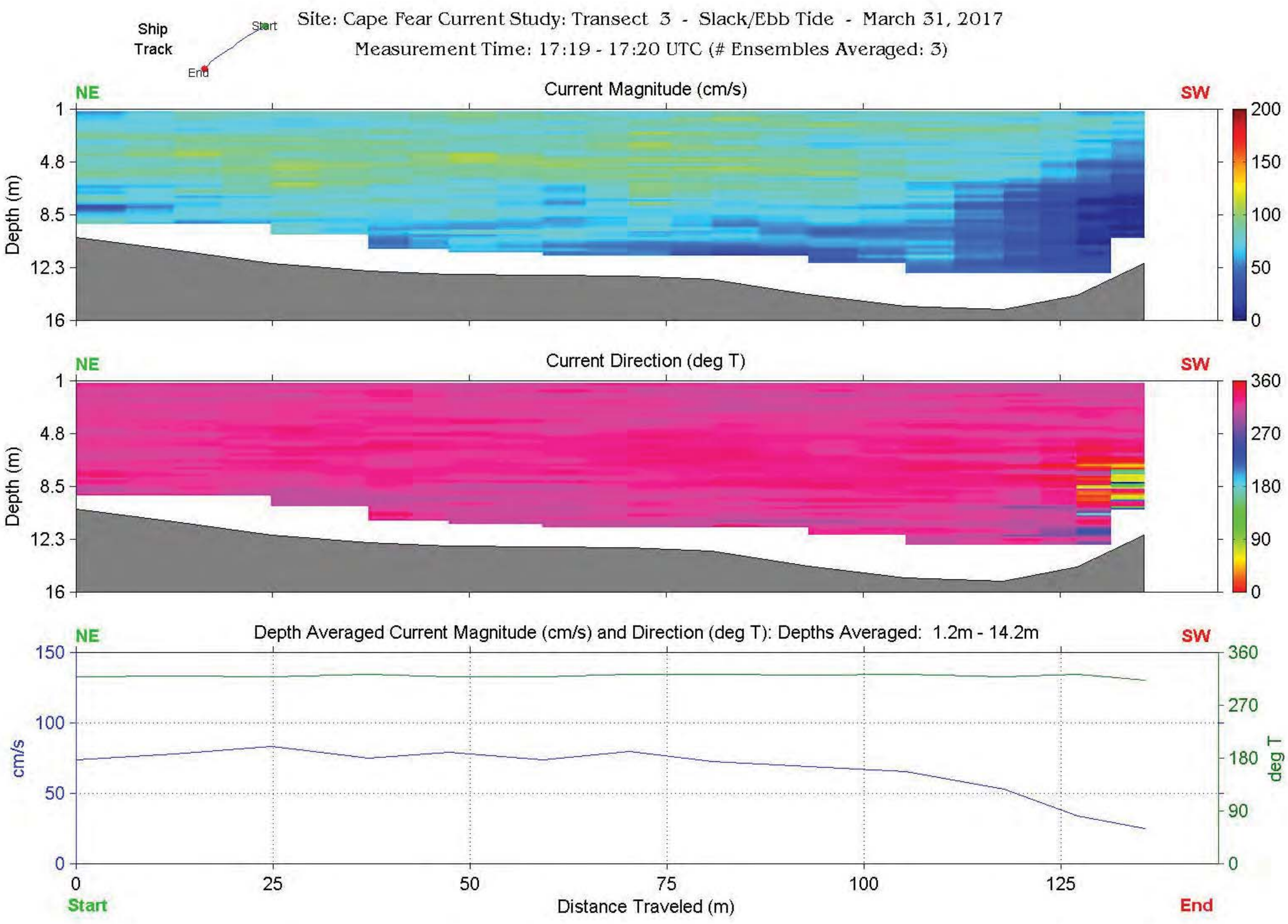

Site: Cape Fear Current Study: Transect 3 - Flood Tide - March 31, 2017

Measurement Time: 16:27 - 16:27 UTC (# Ensembles Averaged: 3)



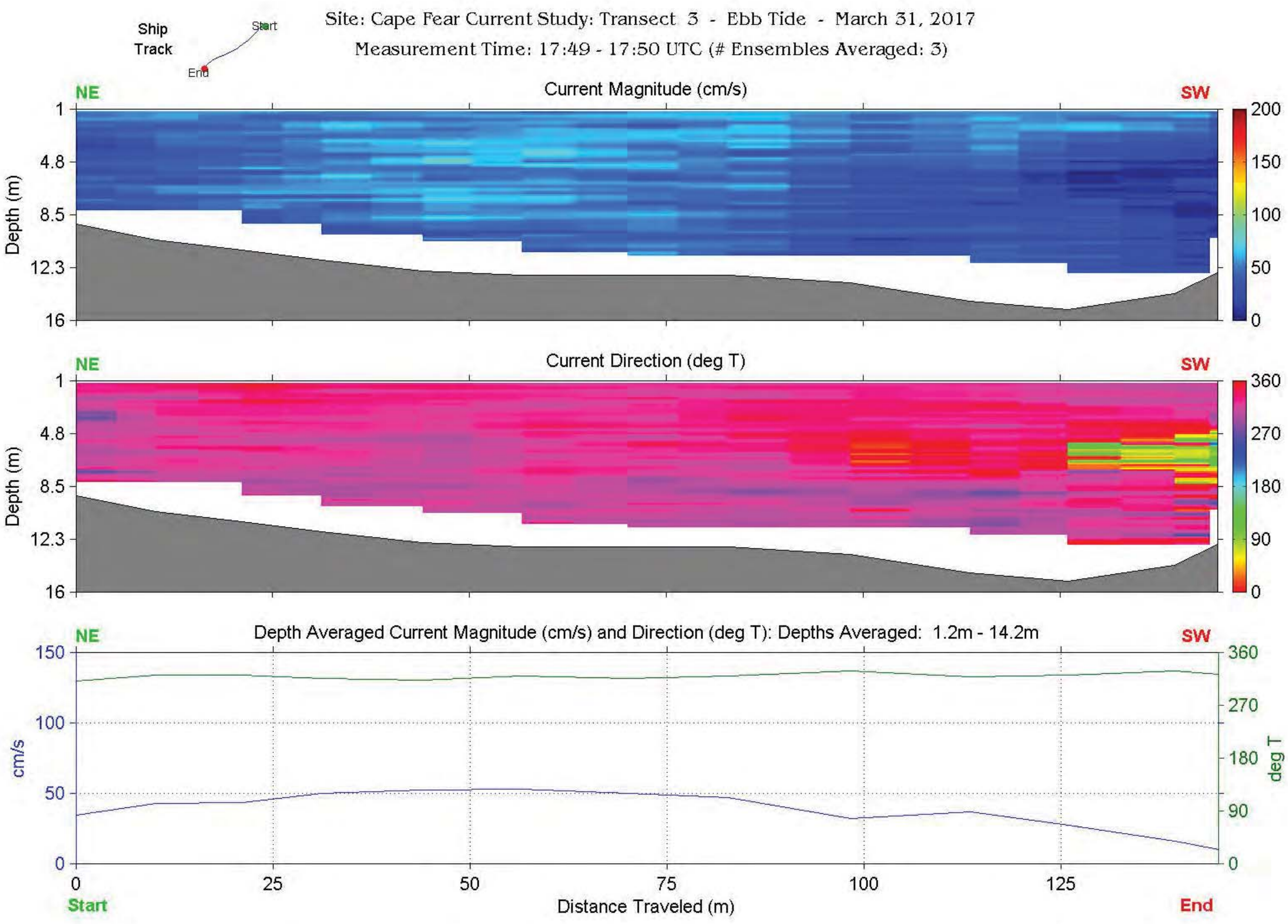
Site: Cape Fear Current Study: Transect 3 - Slack Tide - March 31, 2017

Measurement Time: 16:53 - 16:54 UTC (# Ensembles Averaged: 3)



Site: Cape Fear Current Study: Transect 3 - Slack/Ebb Tide - March 31, 2017

Measurement Time: 17:19 - 17:20 UTC (# Ensembles Averaged: 3)

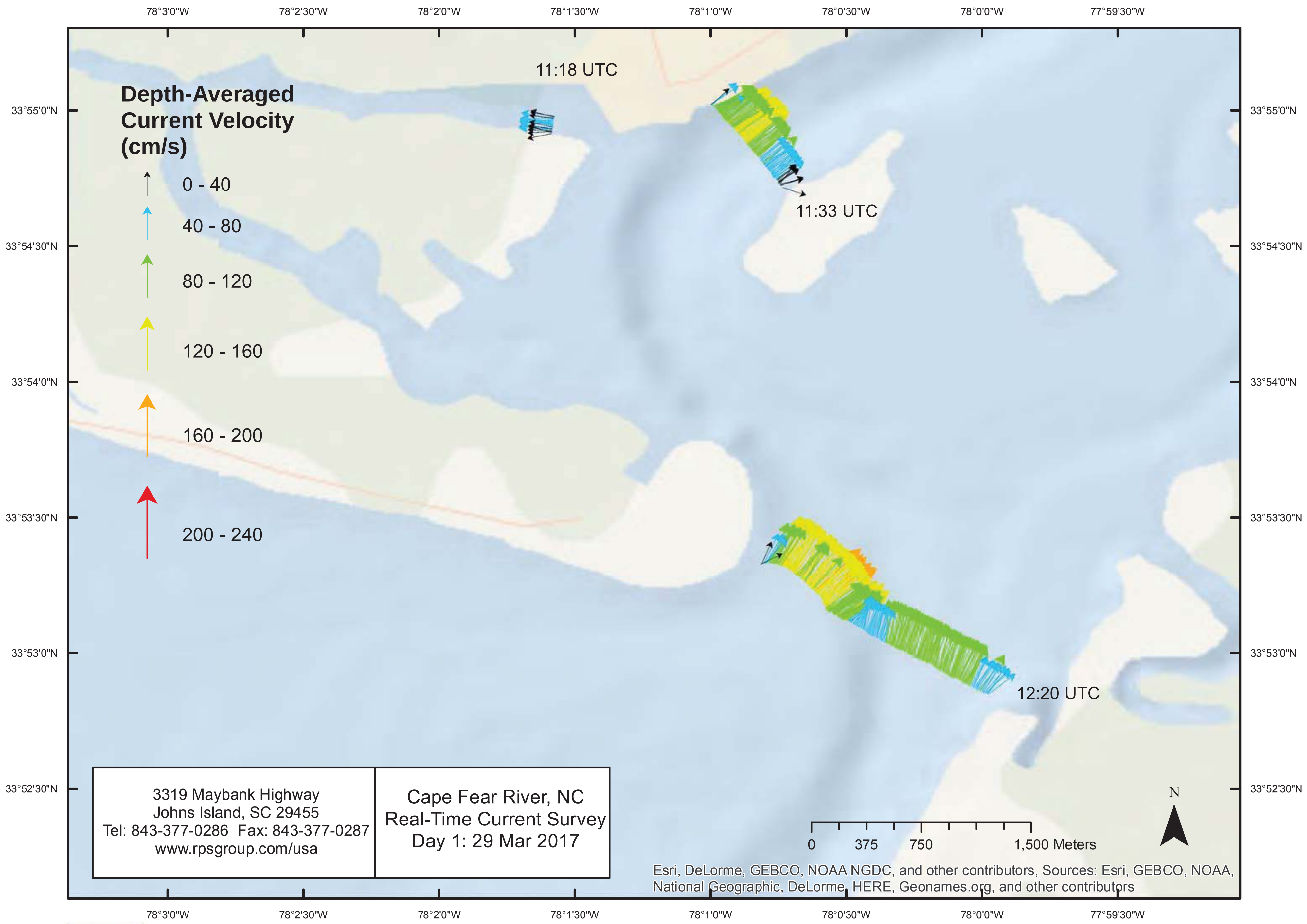


Site: Cape Fear Current Study: Transect 3 - Ebb Tide - March 31, 2017

Measurement Time: 17:49 - 17:50 UTC (# Ensembles Averaged: 3)

APPENDIX VI Vessel Mounted Current Survey Vector Plots

Southport



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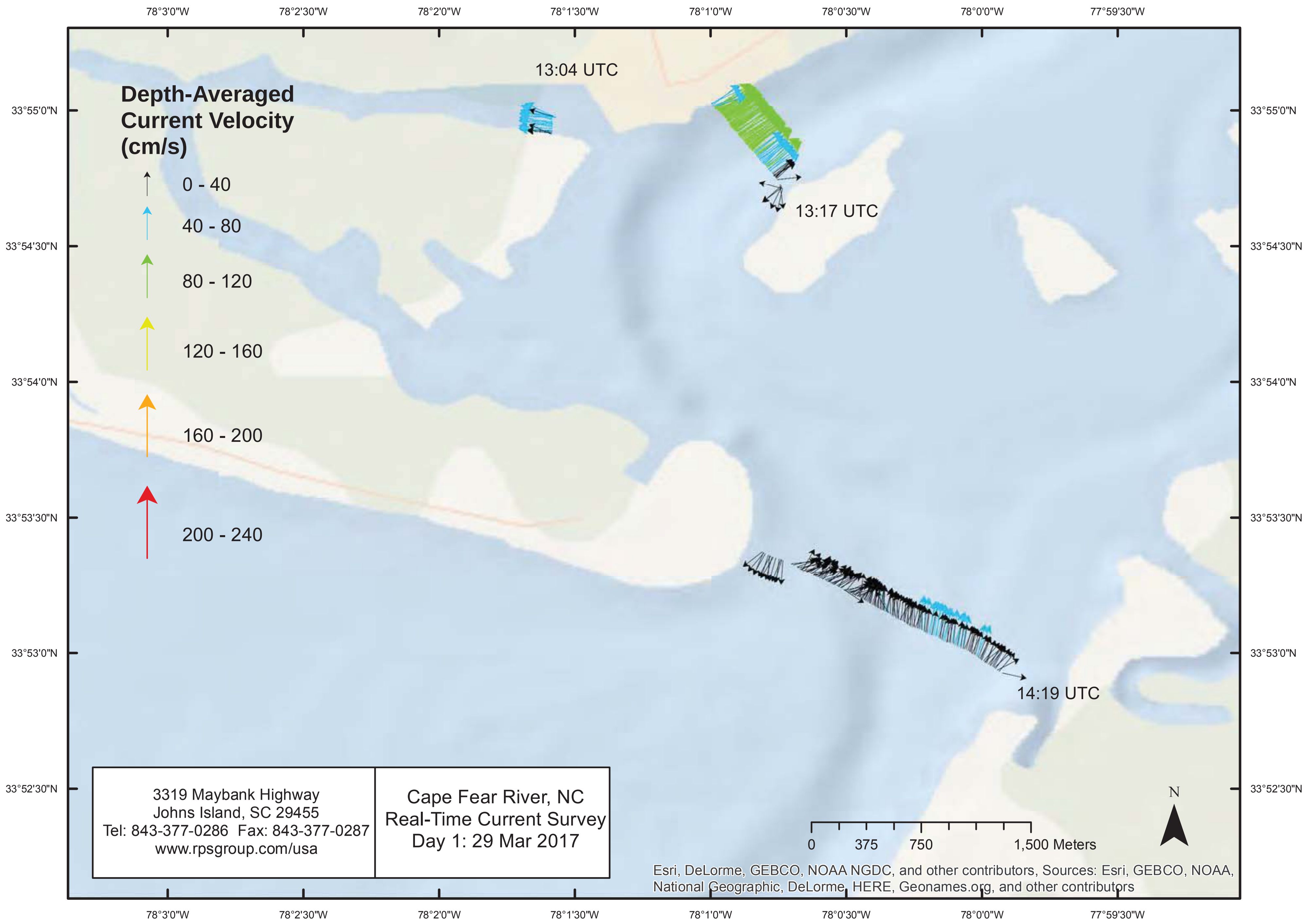
www.rpsgroup.com/usa

Cape Fear River, NC
Real-Time Current Survey
Day 1: 29 Mar 2017

Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors, Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

RPS

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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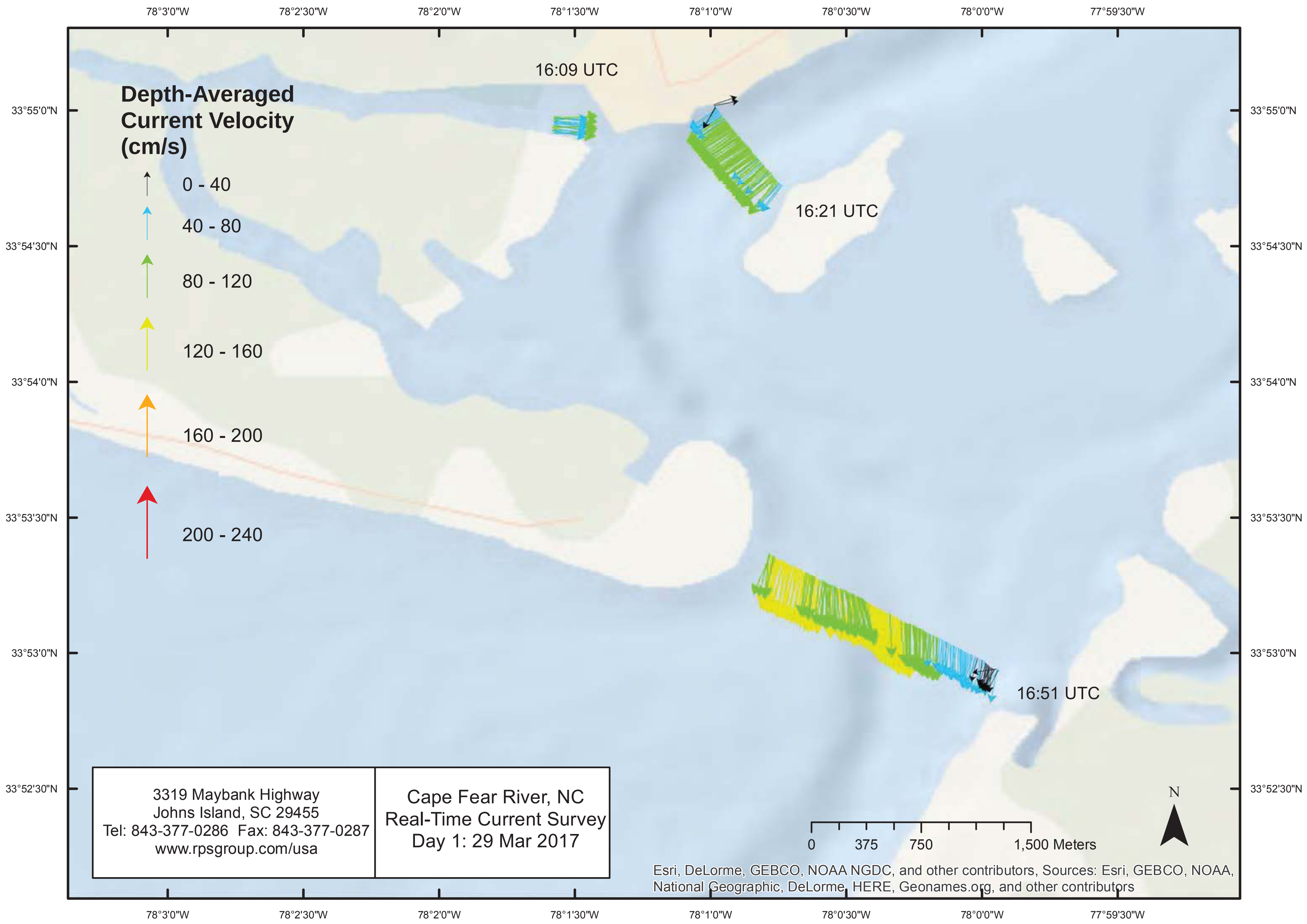
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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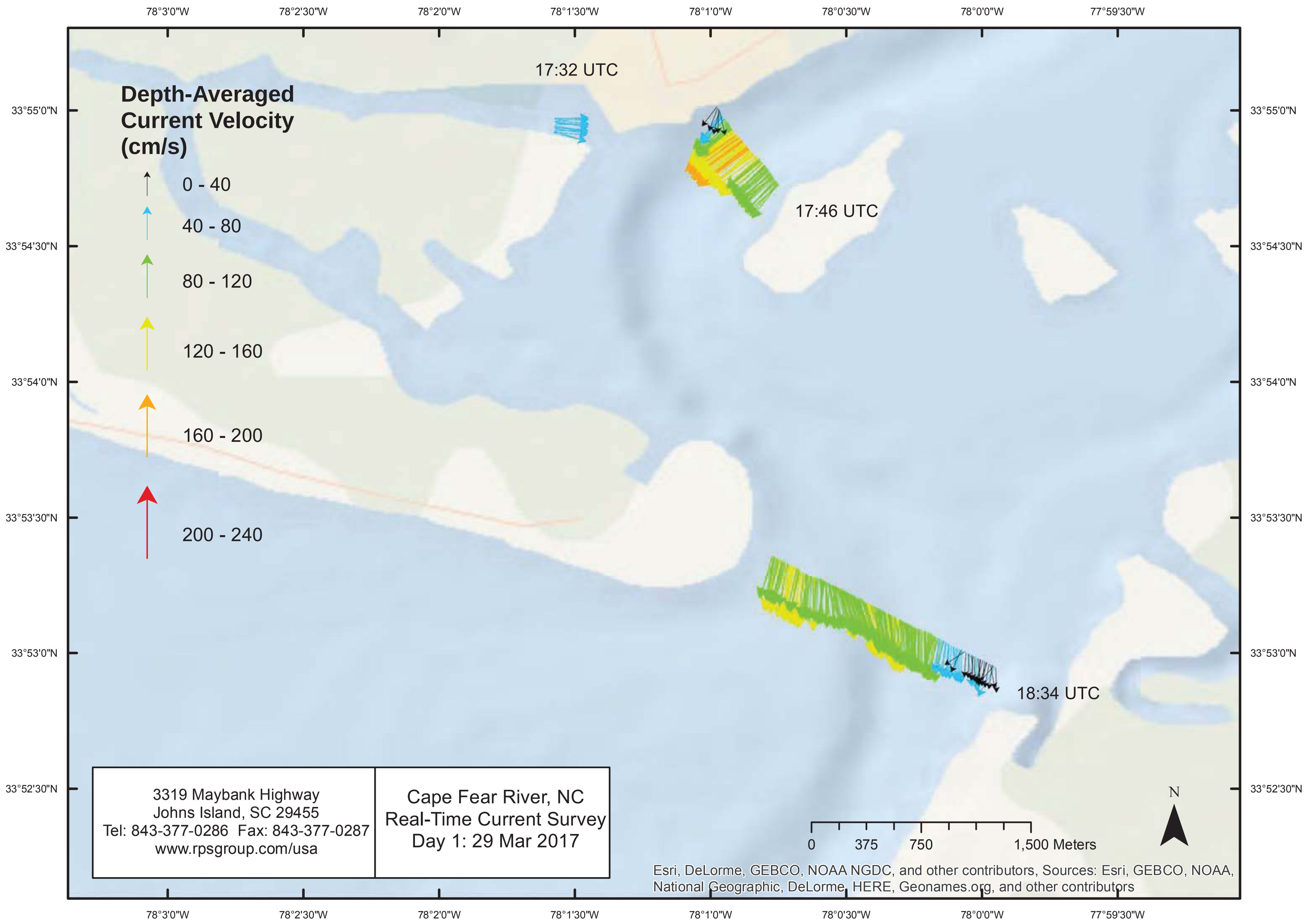
Day 1: 29 Mar 2017

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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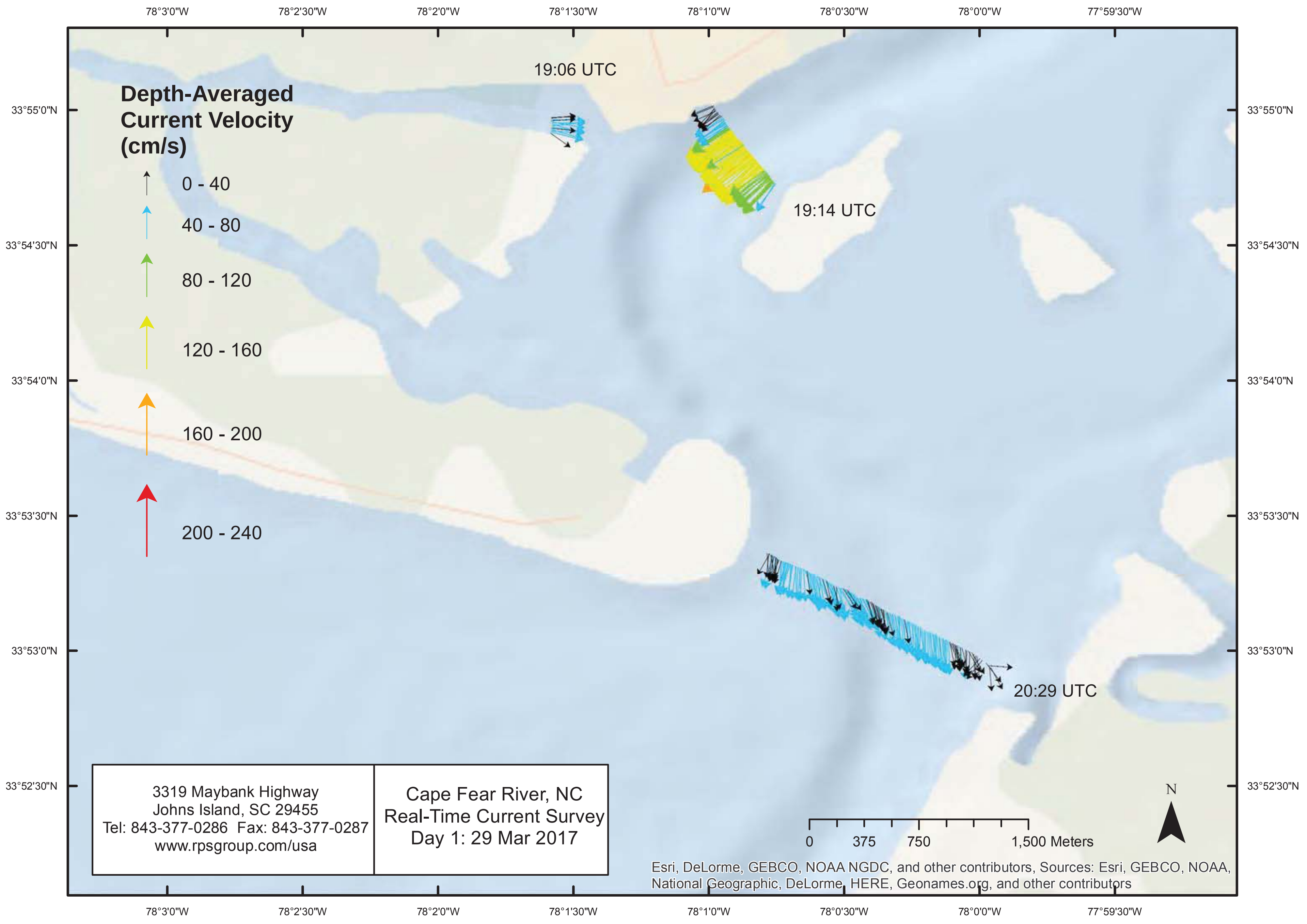
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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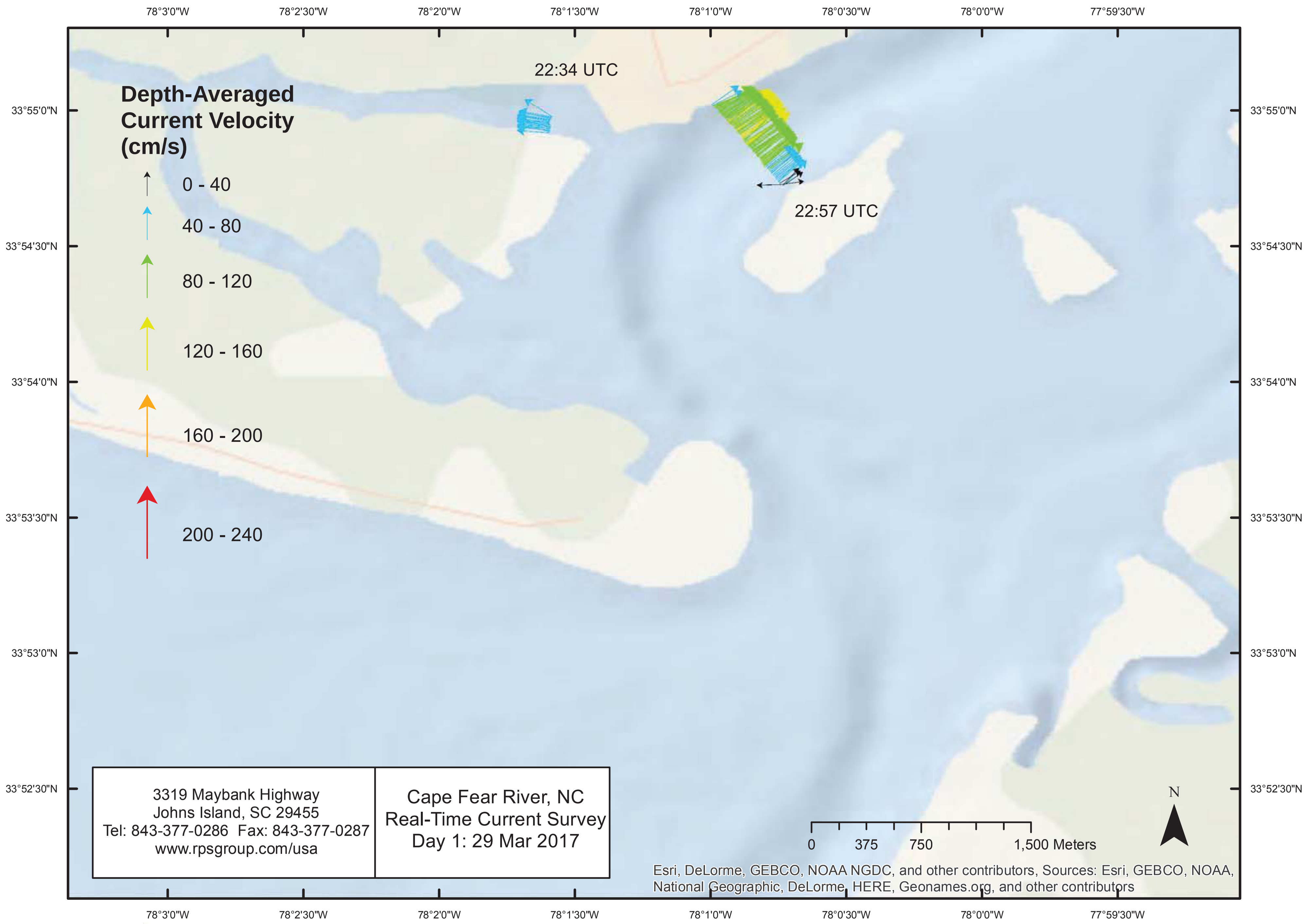
Day 1: 29 Mar 2017

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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Cape Fear River, NC
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Day 1: 29 Mar 2017

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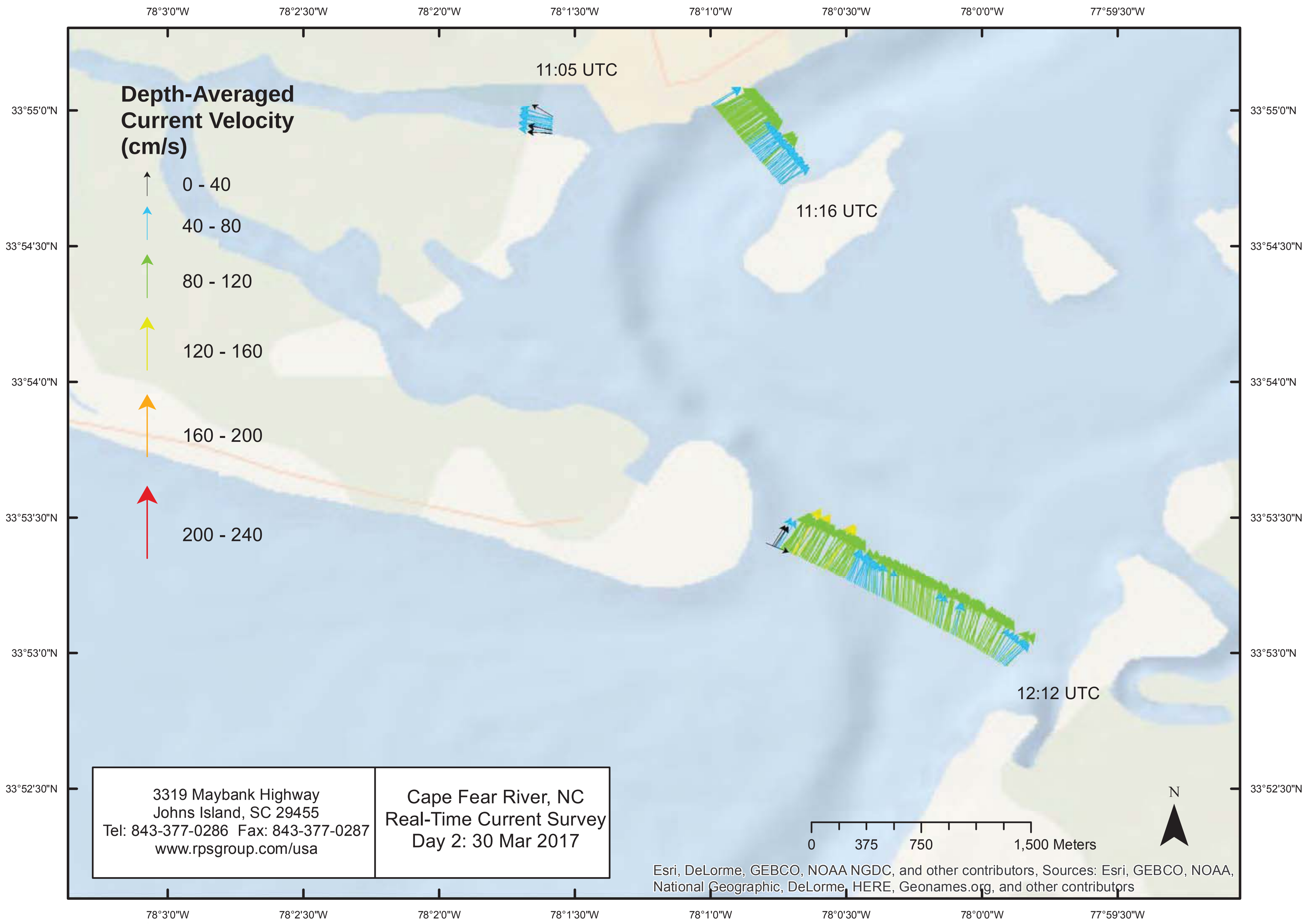
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



Cape Fear River, NC
Real-Time Current Survey
Day 2: 30 Mar 2017

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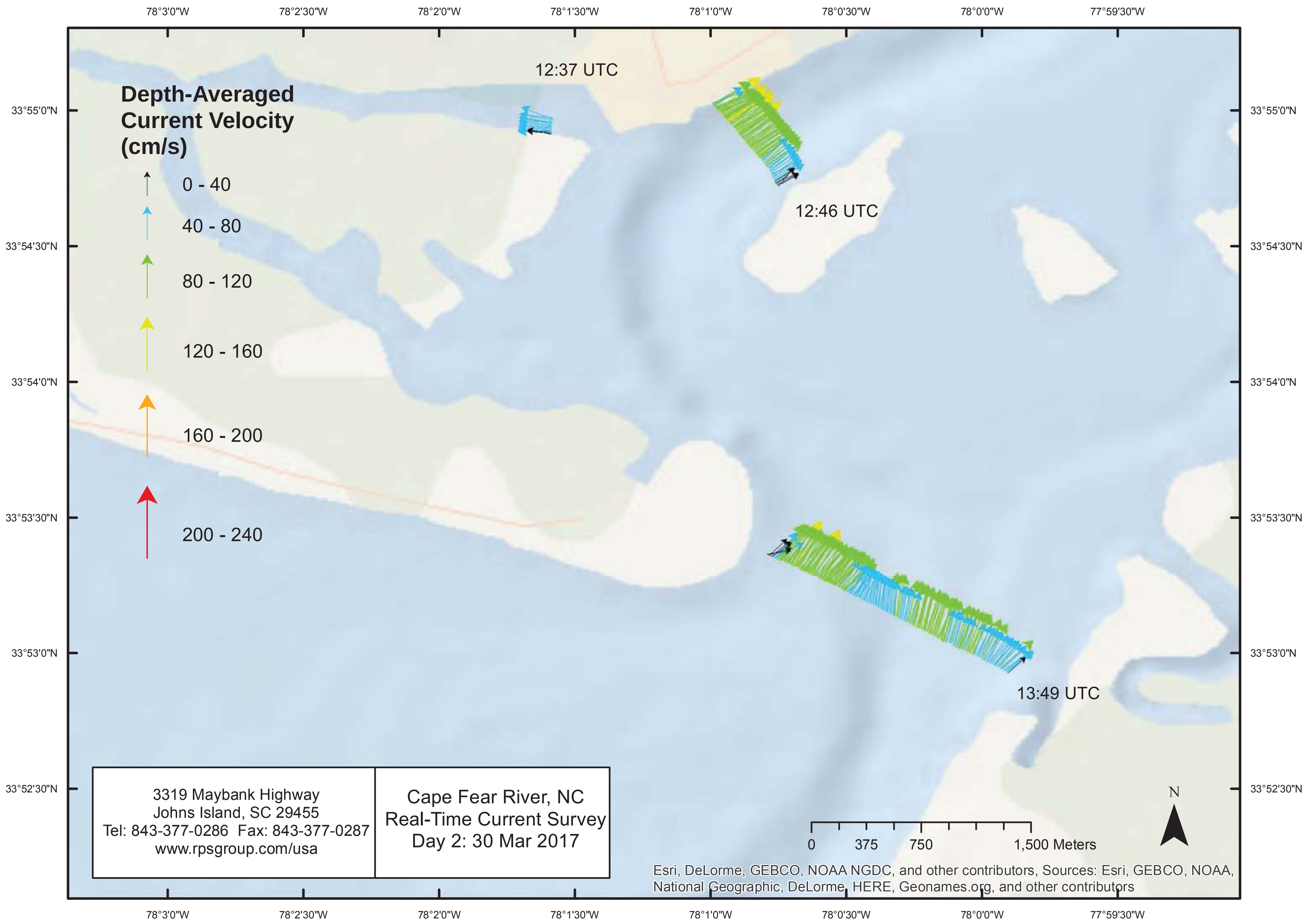
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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Cape Fear River, NC
Real-Time Current Survey
Day 2: 30 Mar 2017

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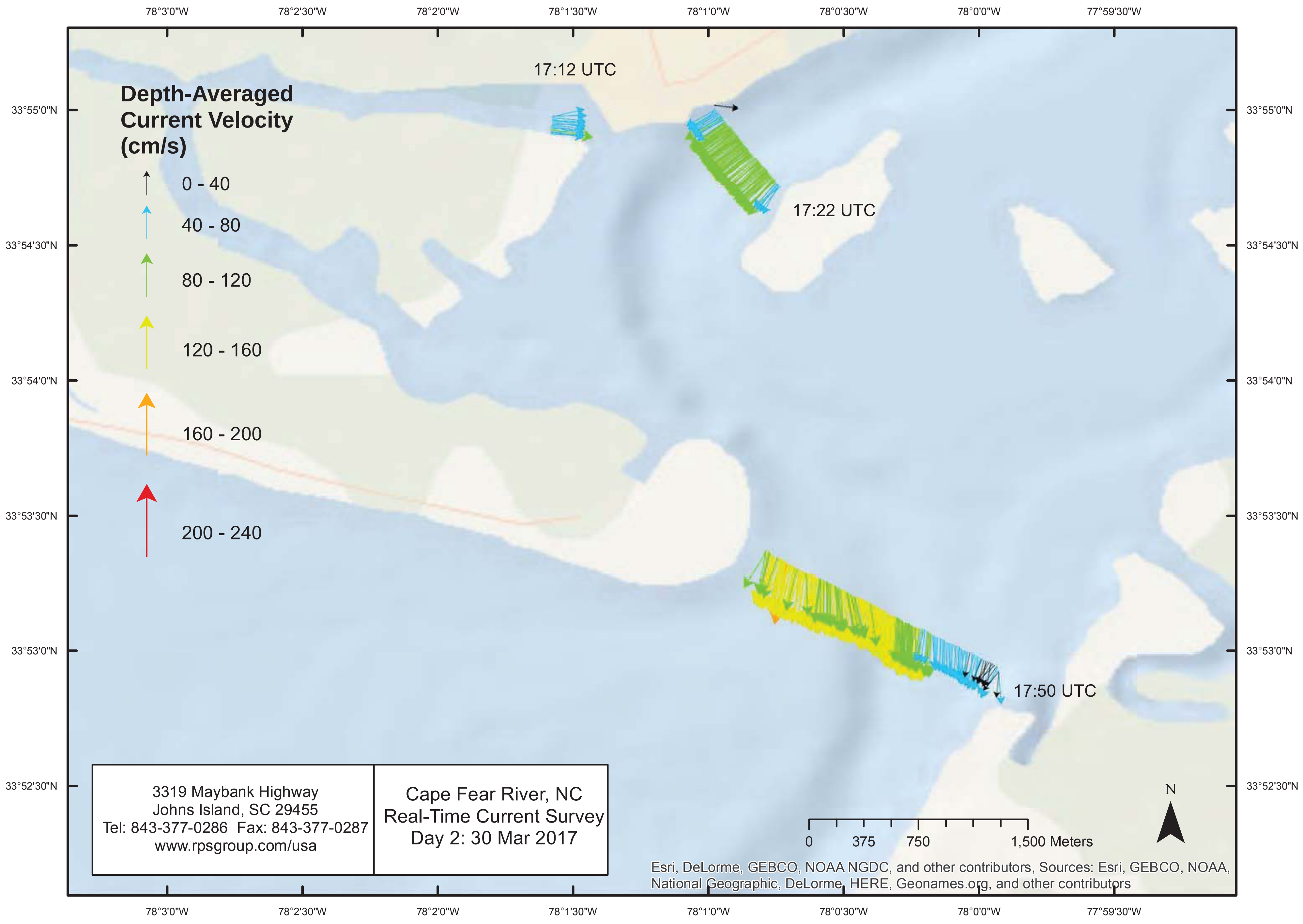
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



Cape Fear River, NC
Real-Time Current Survey
Day 2: 30 Mar 2017

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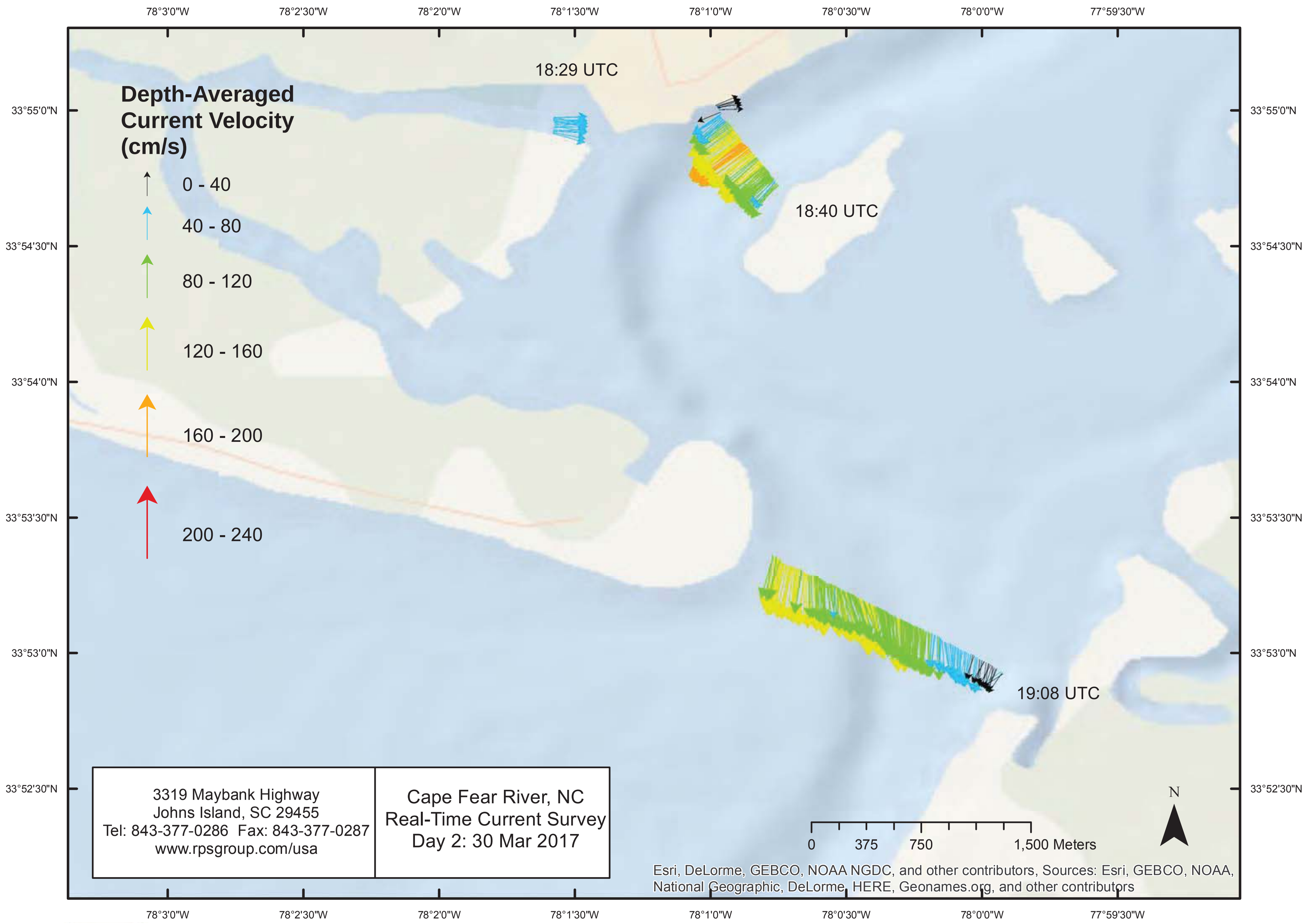
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



Cape Fear River, NC
Real-Time Current Survey
Day 2: 30 Mar 2017

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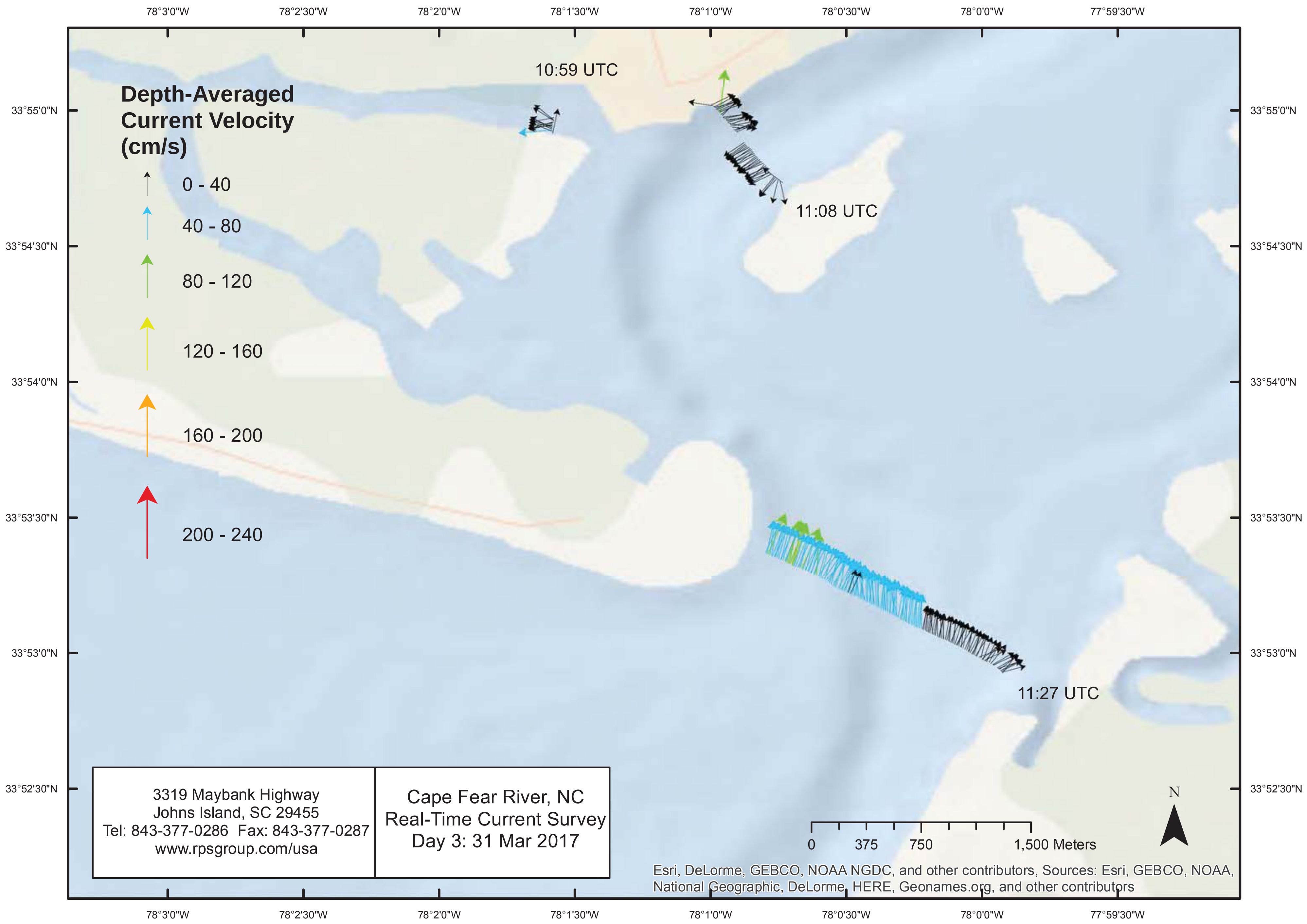
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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Johns Island, SC 29455
Tel: 843-377-0286 Fax: 843-377-0287
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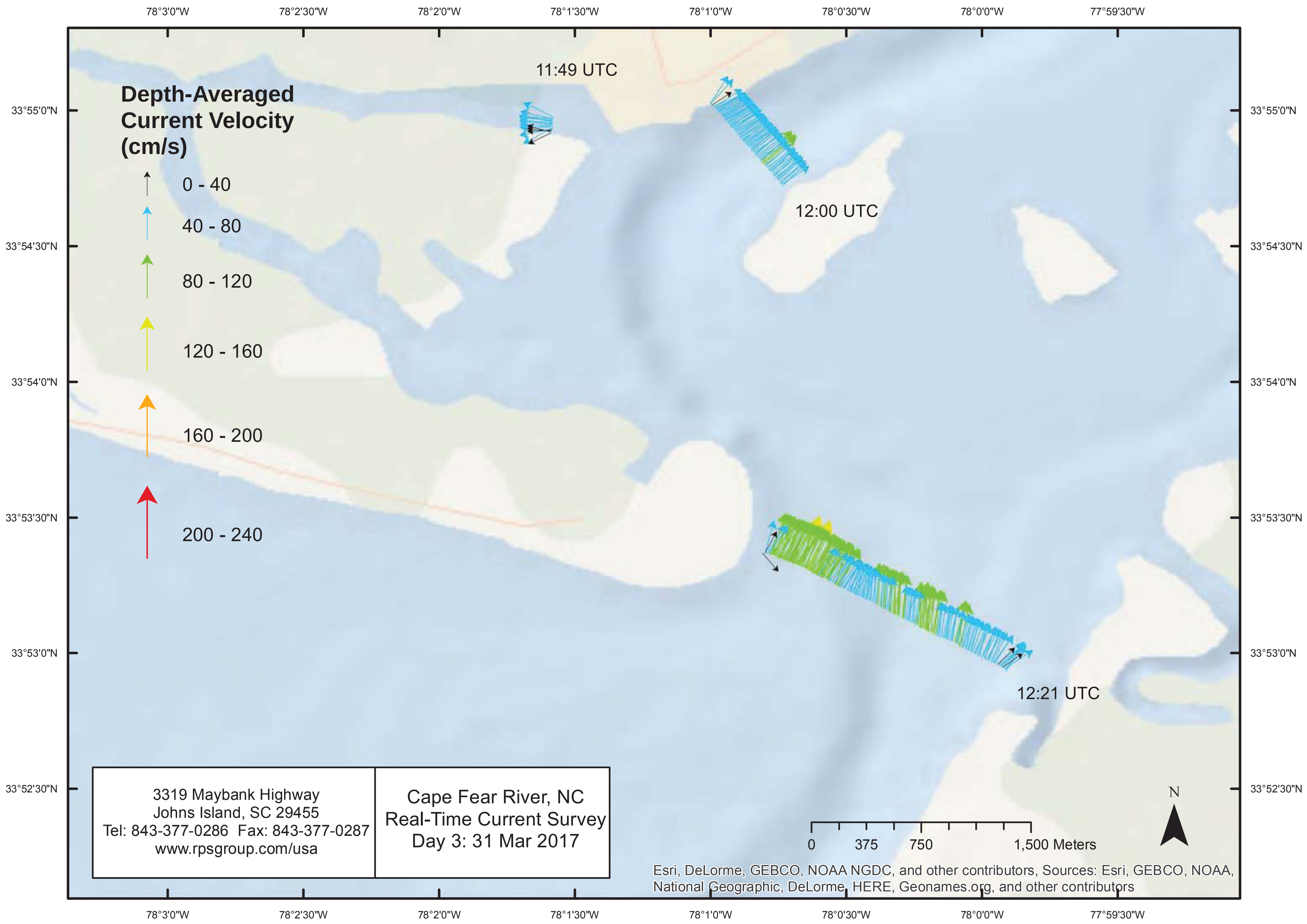
Cape Fear River, NC
Real-Time Current Survey
Day 3: 31 Mar 2017

Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors, Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree



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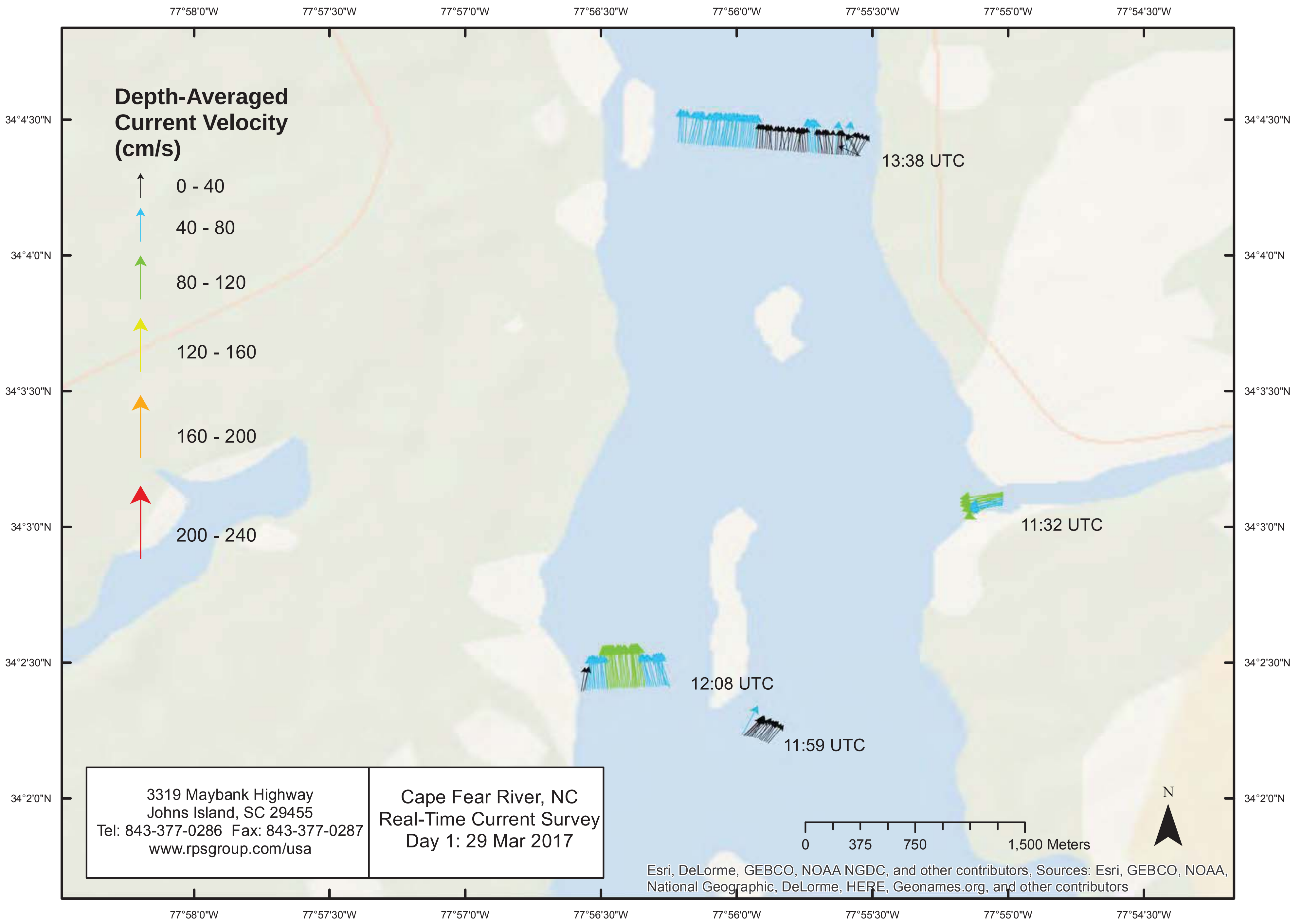
Cape Fear River, NC
Real-Time Current Survey
Day 3: 31 Mar 2017

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

Snow’s Cut



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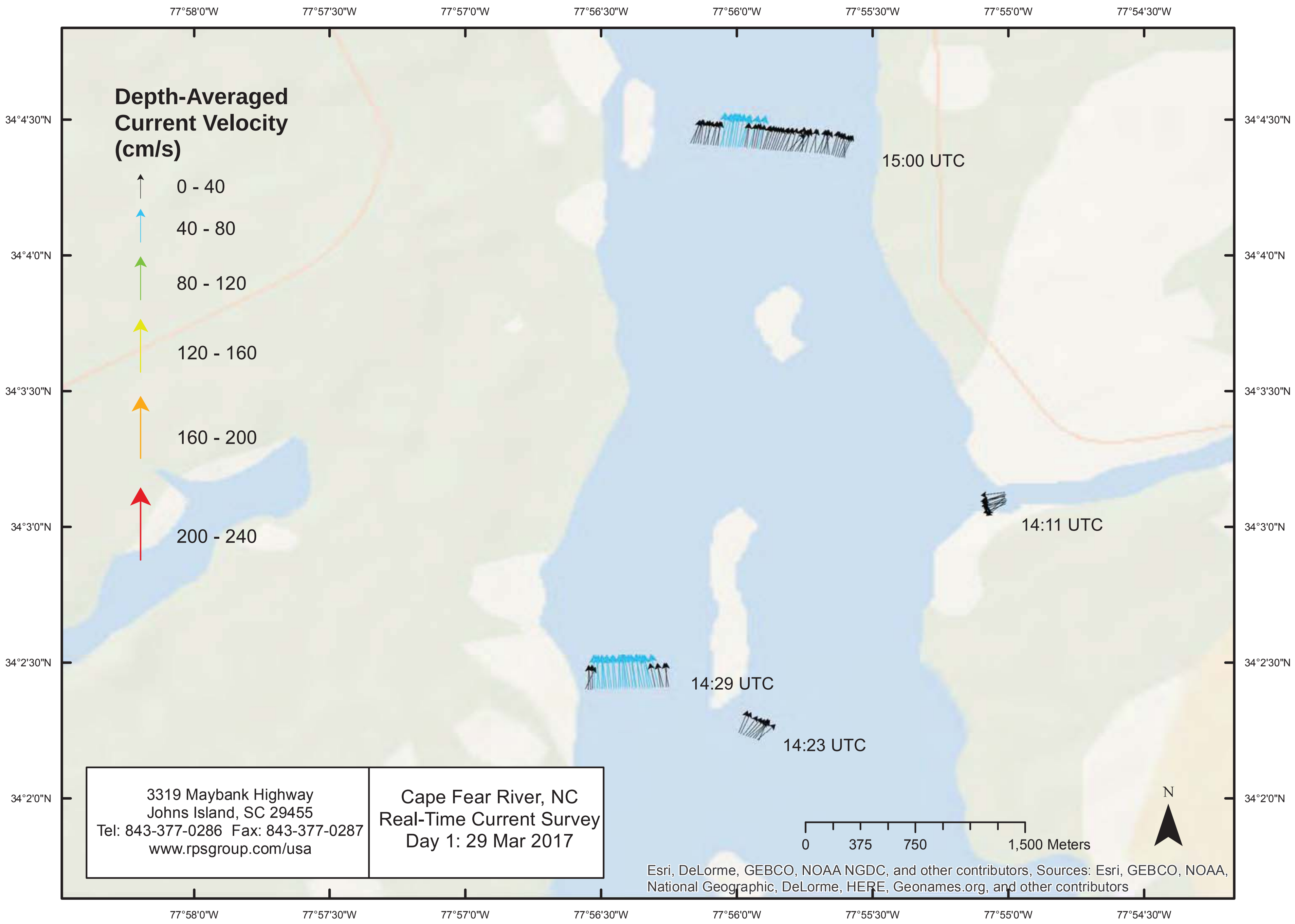

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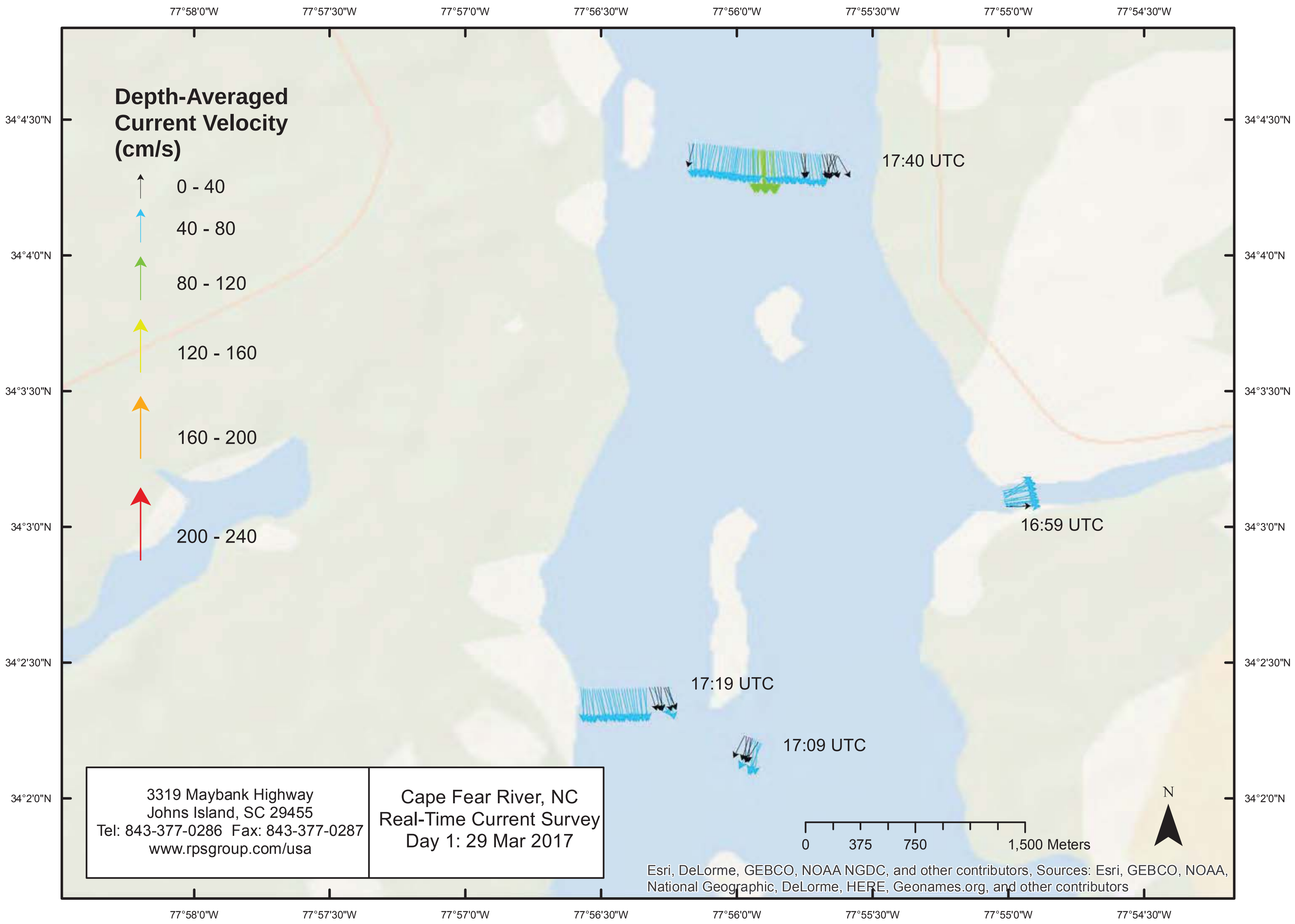

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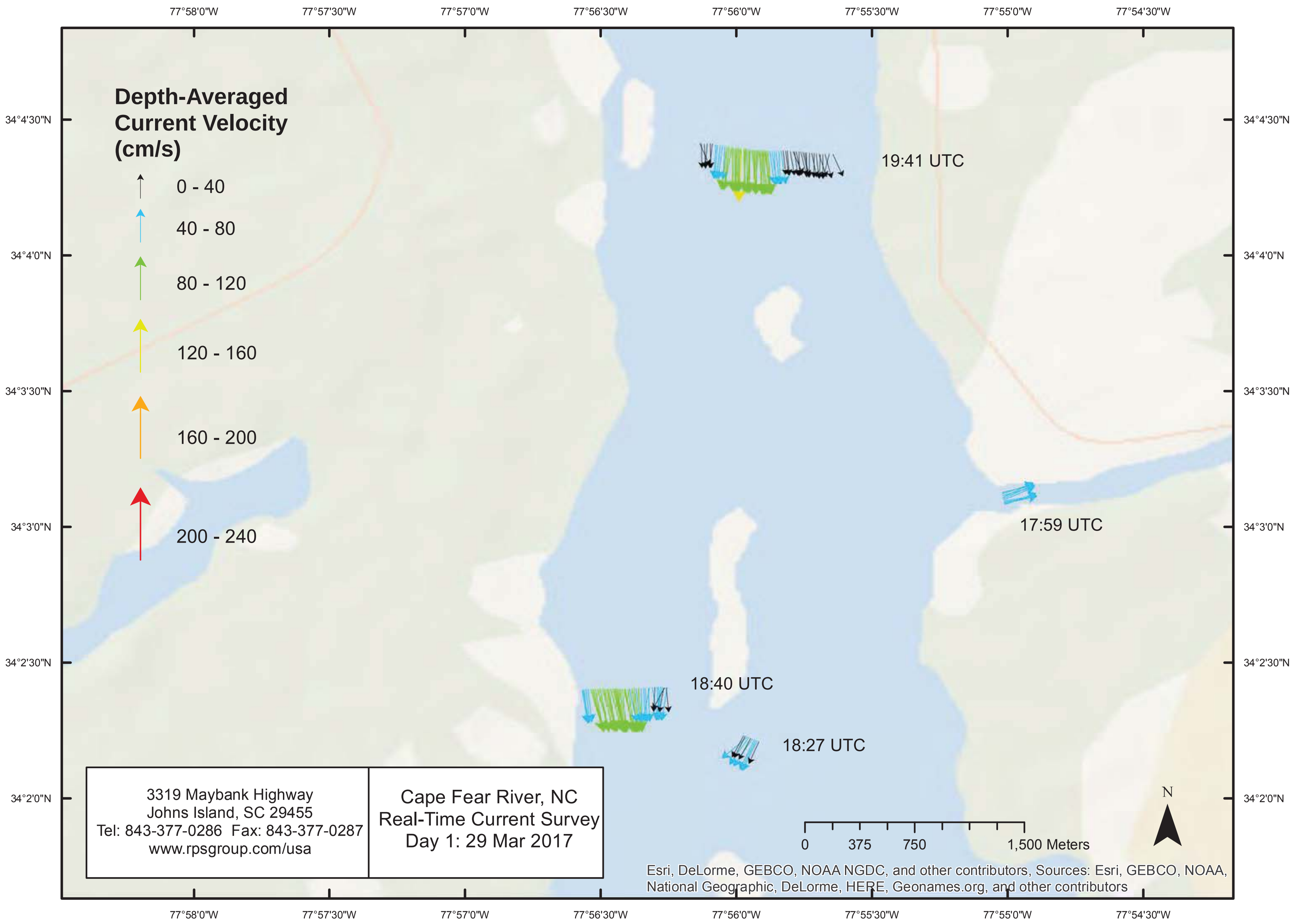

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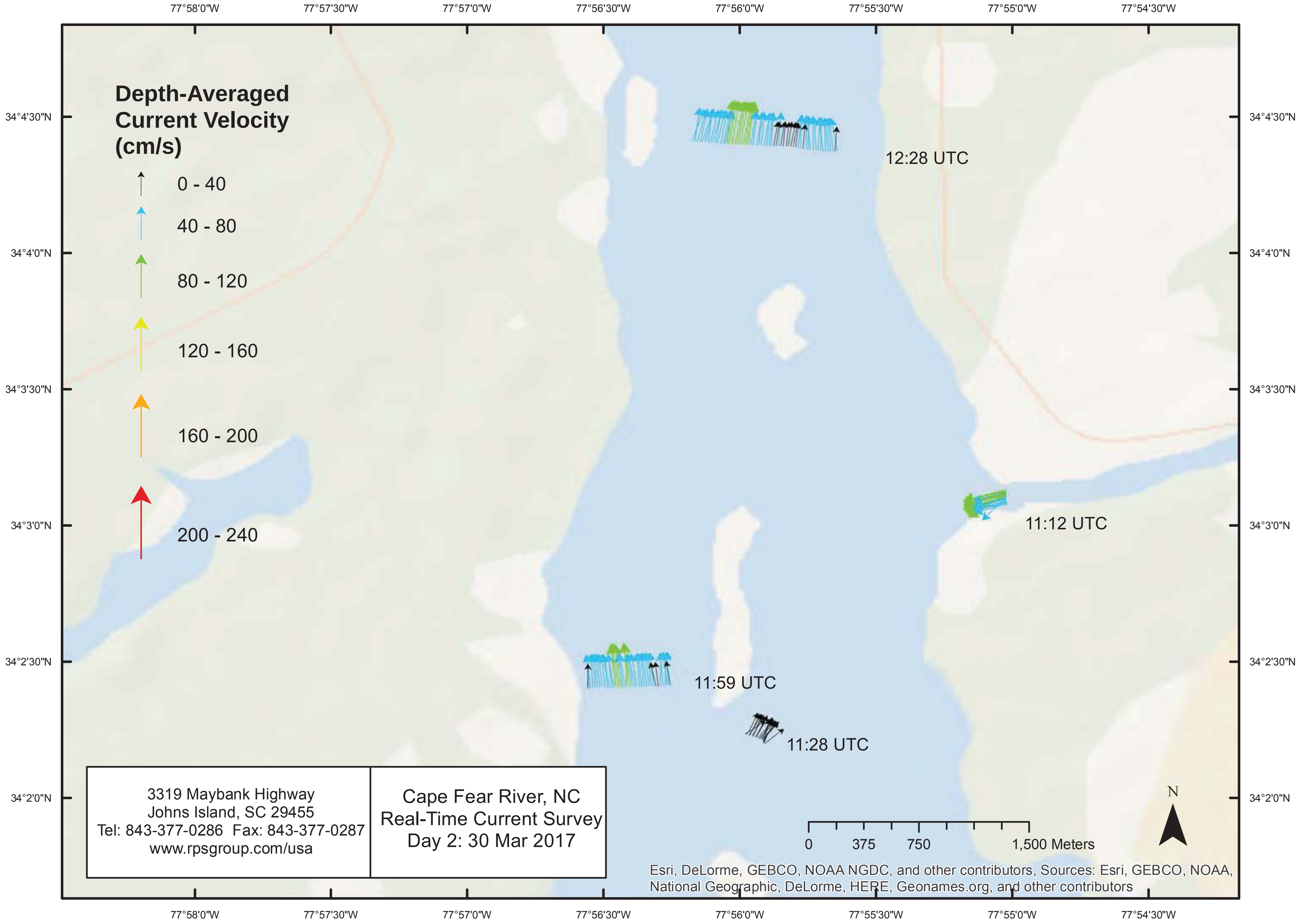

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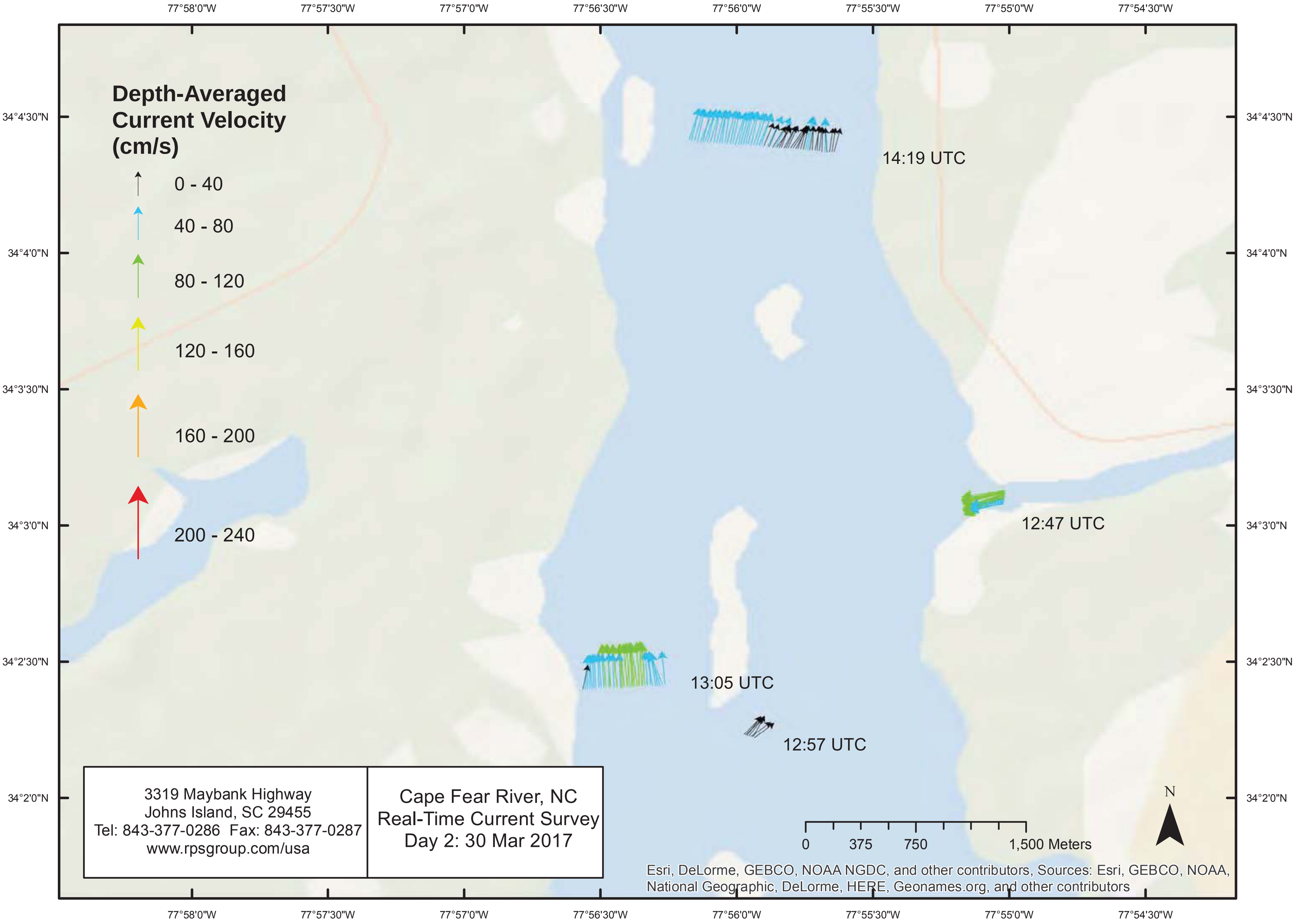

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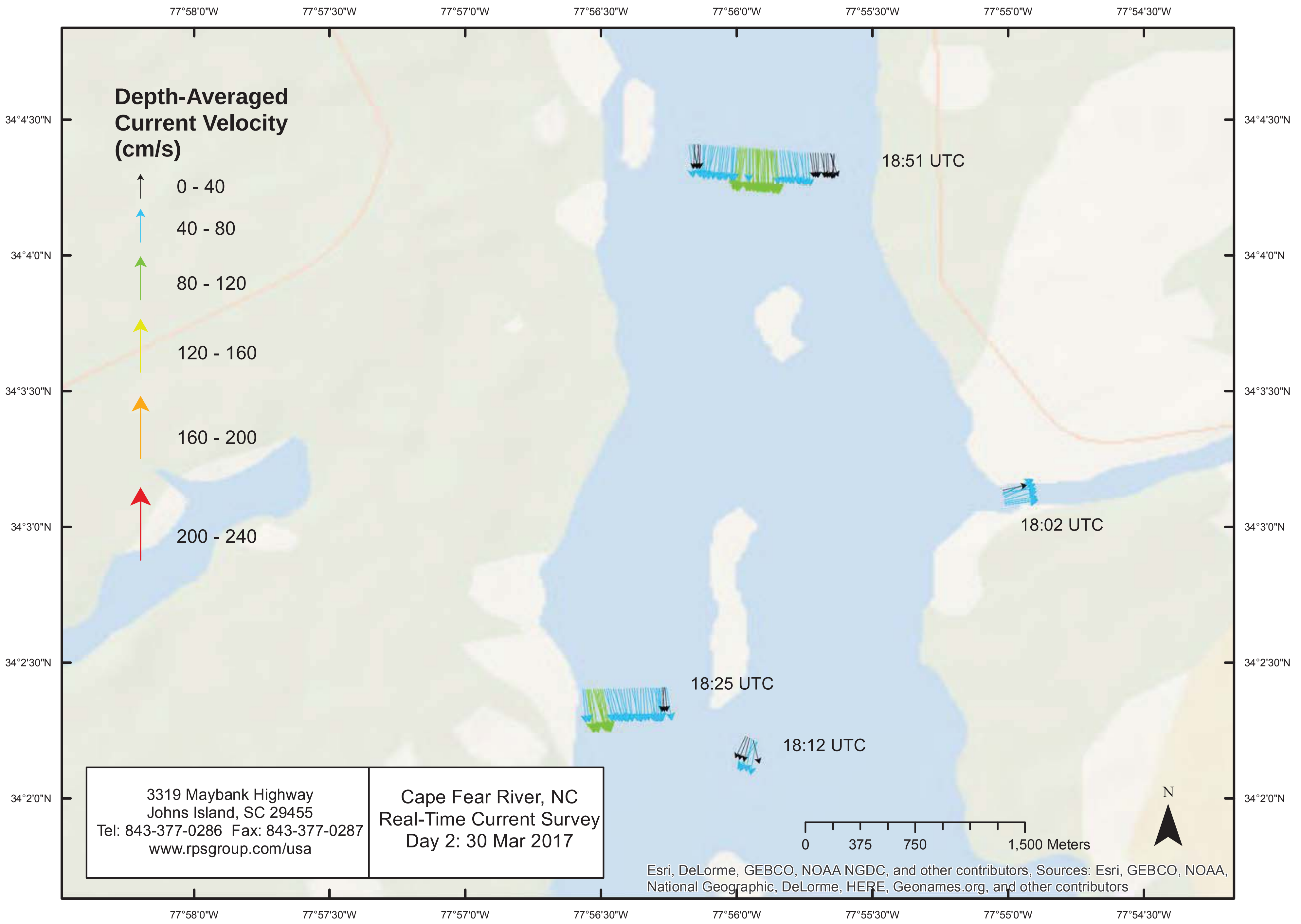

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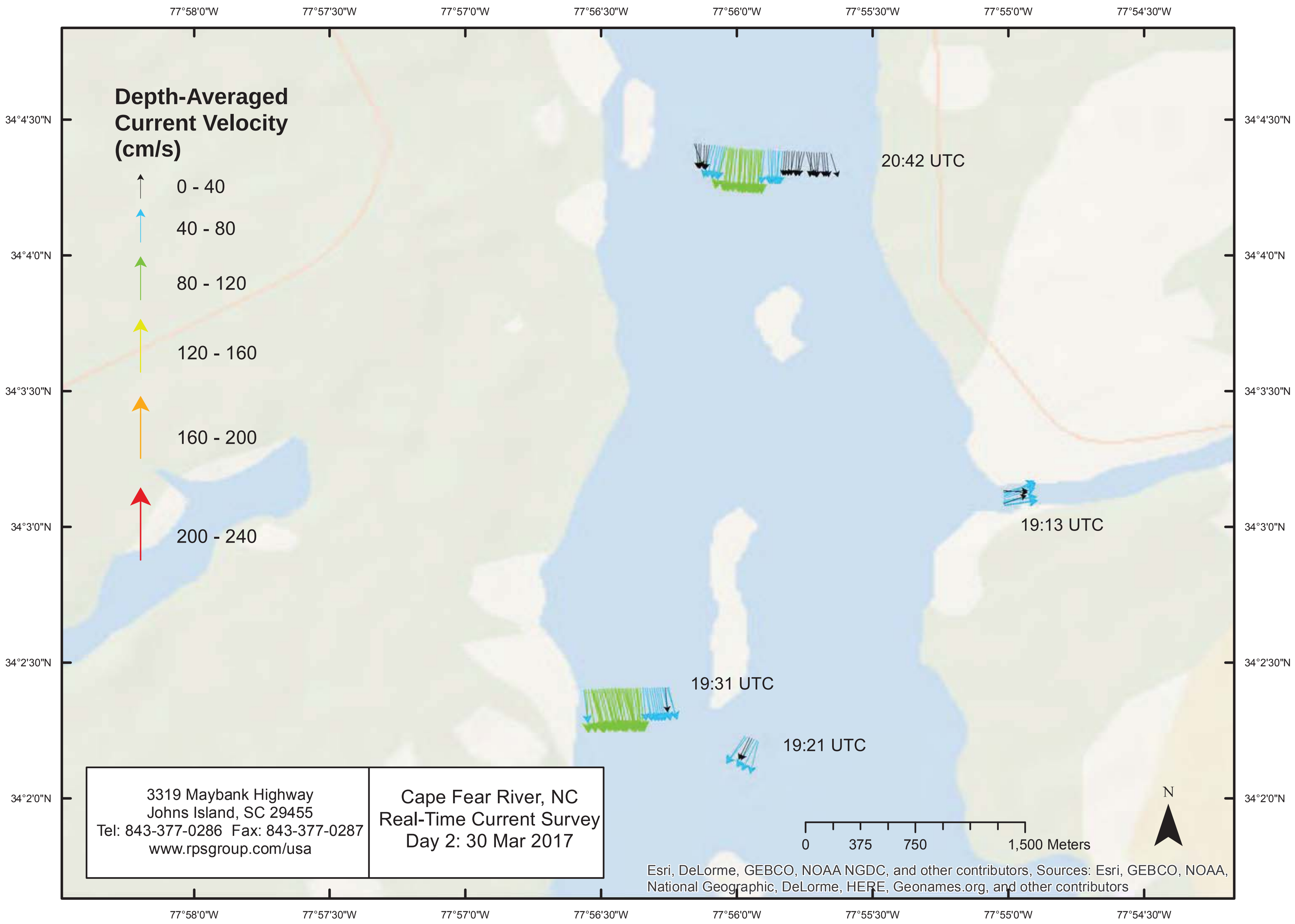

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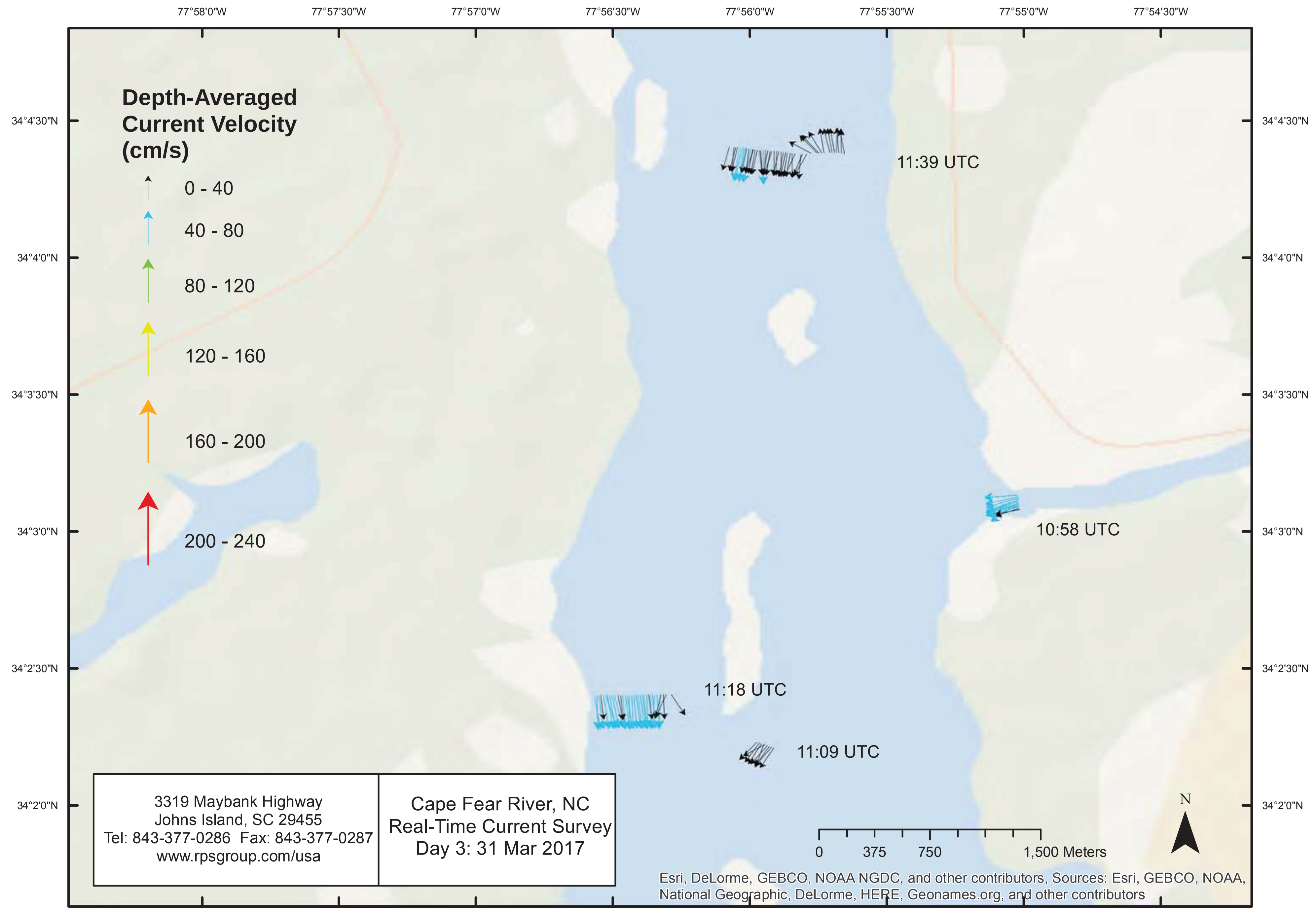

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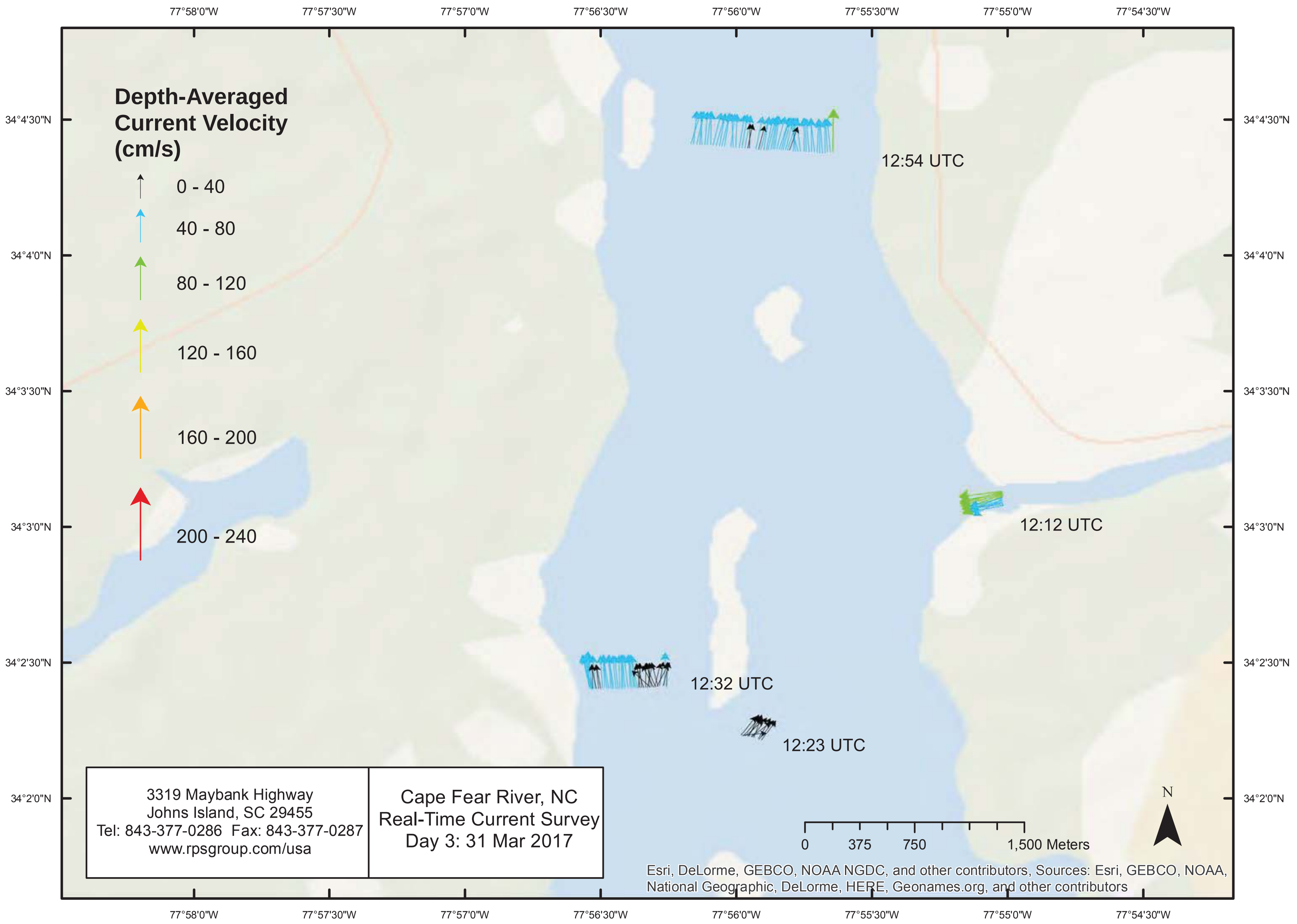

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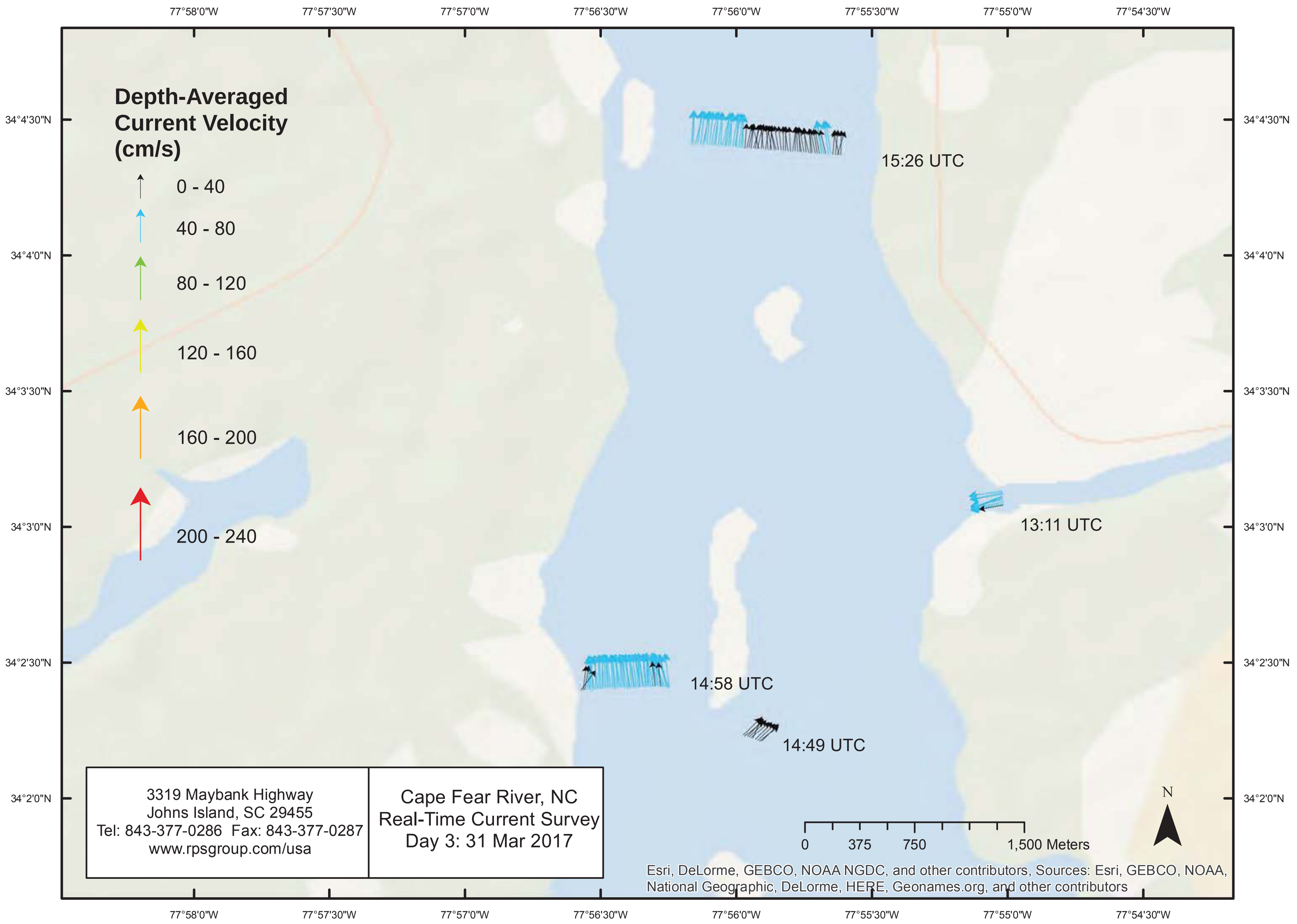

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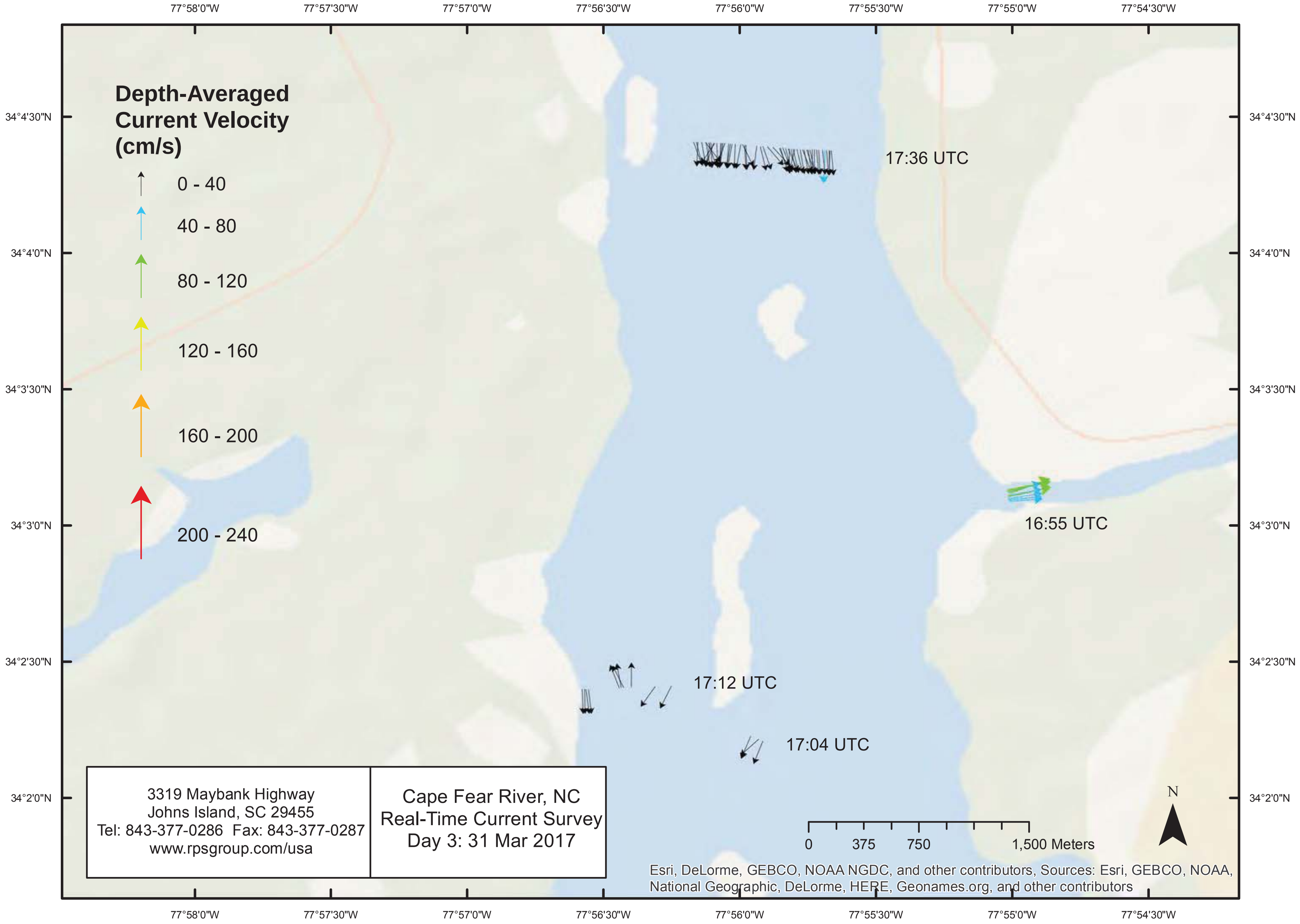

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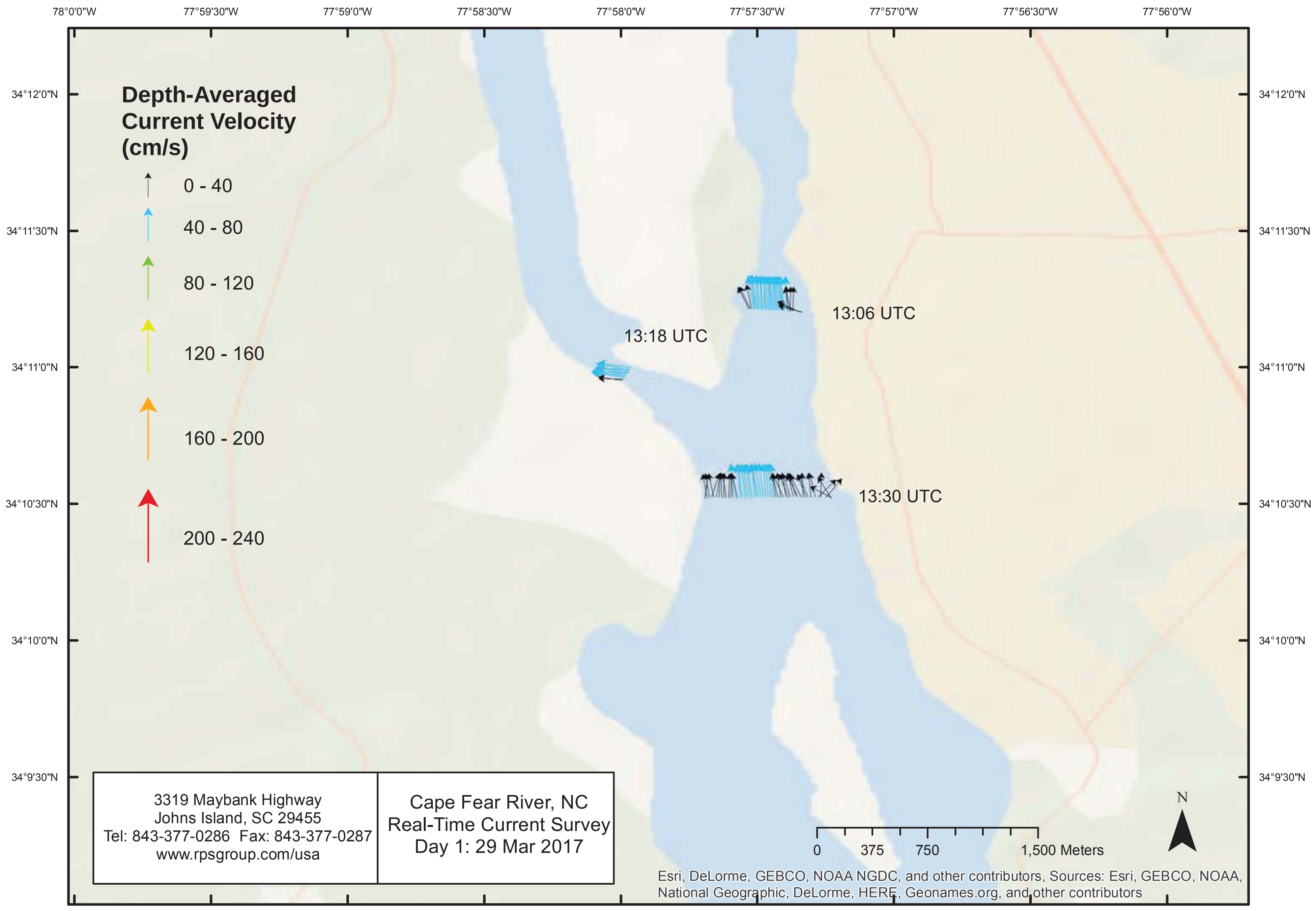
Wilmington
South of Port



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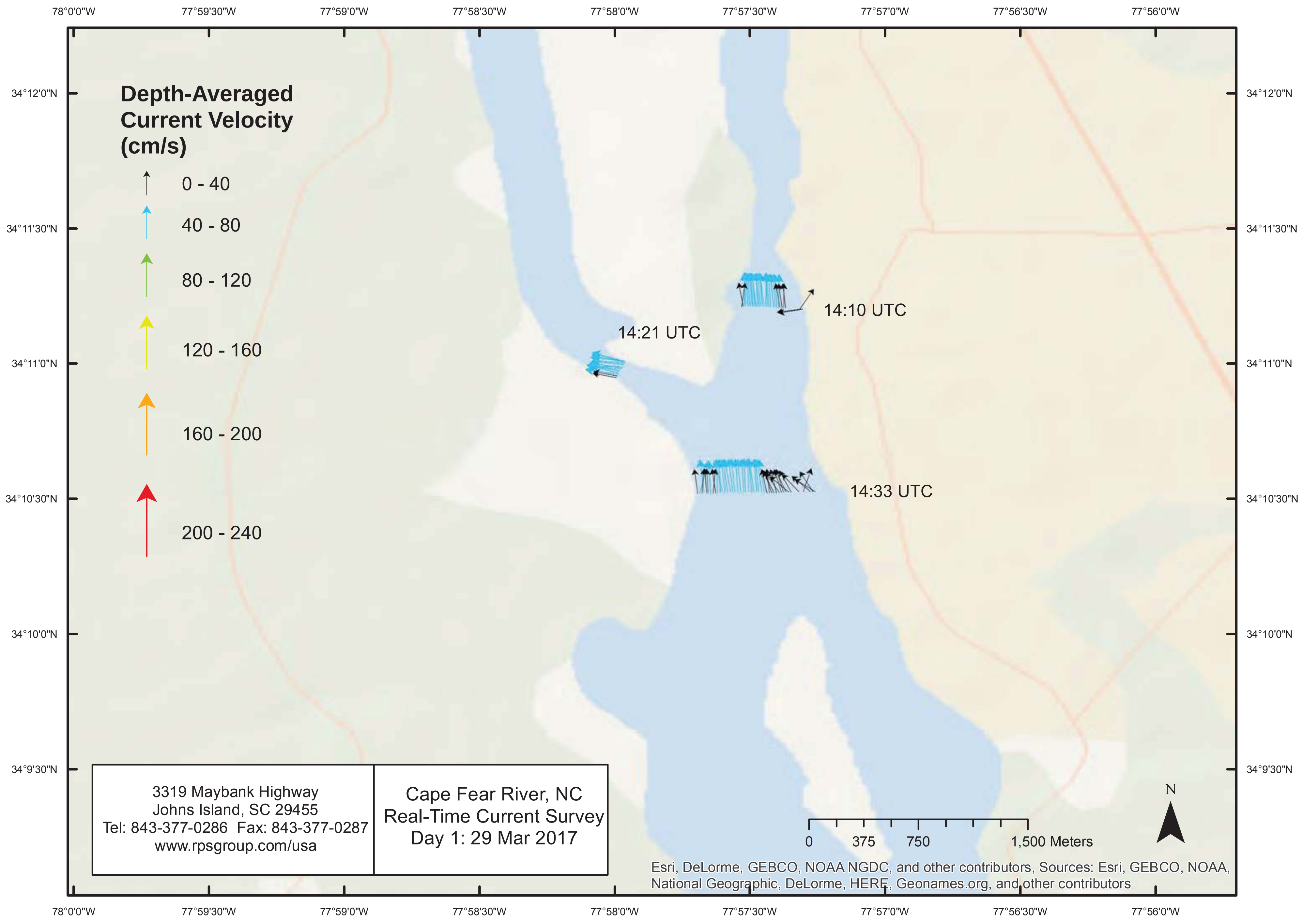

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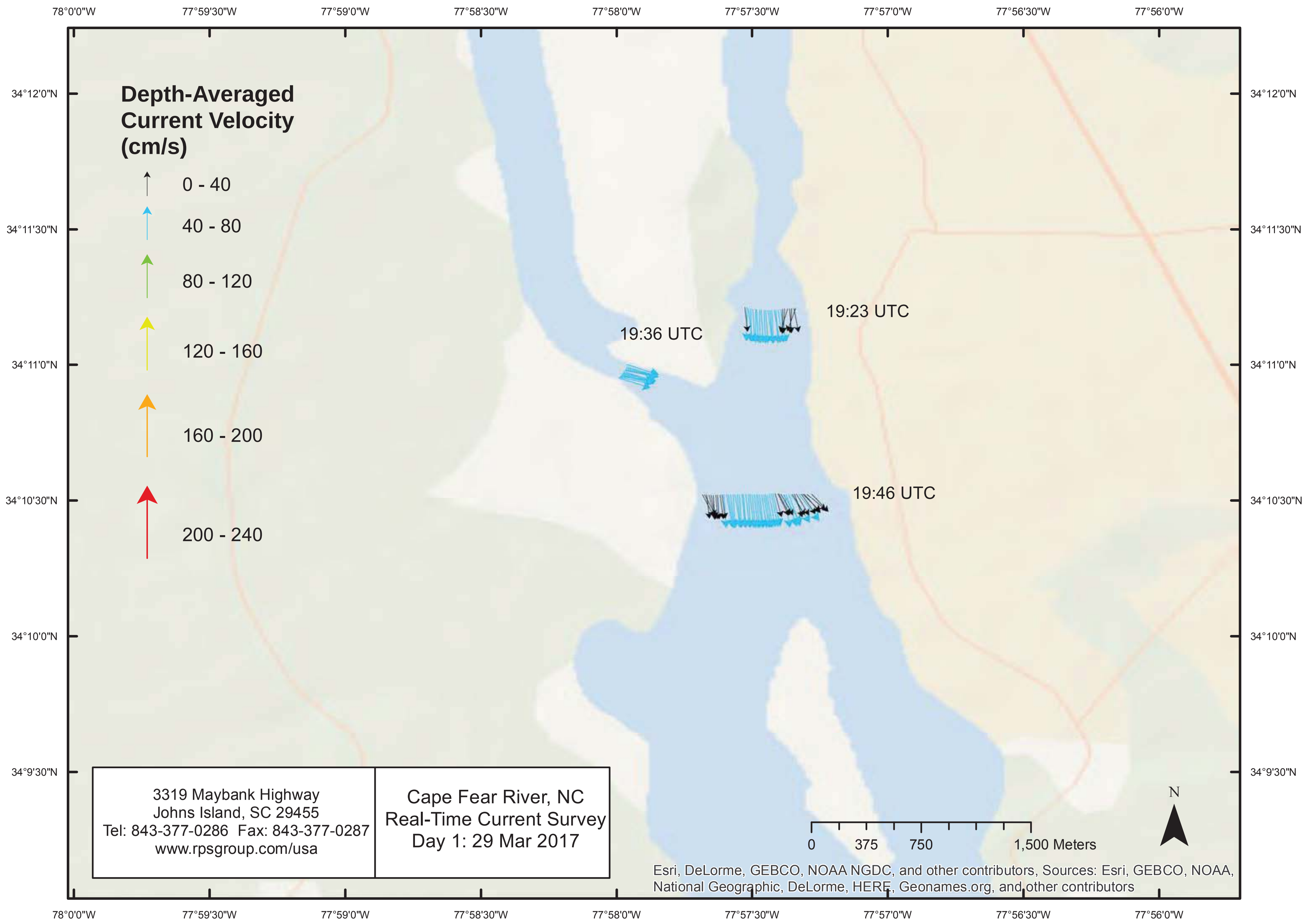

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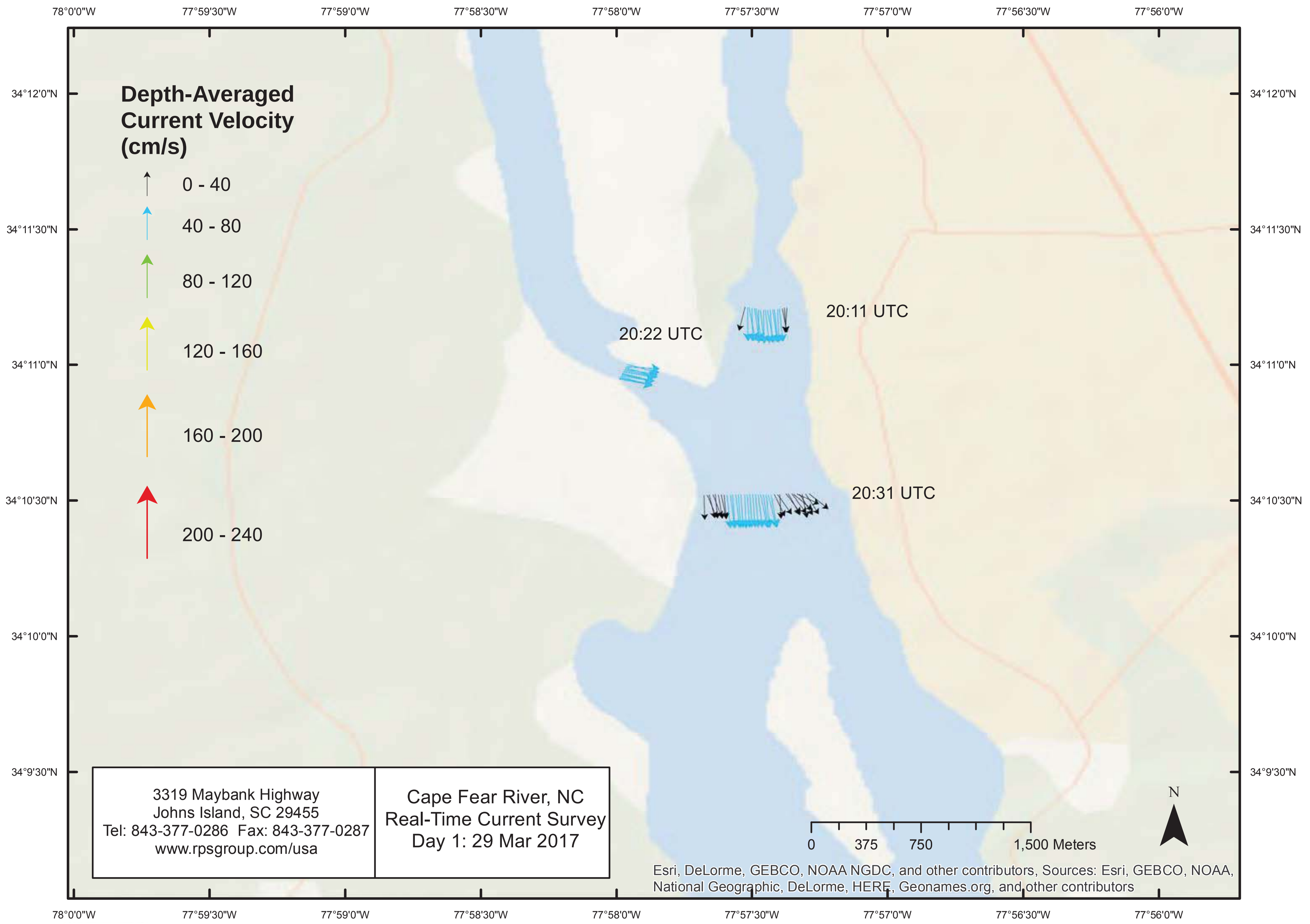

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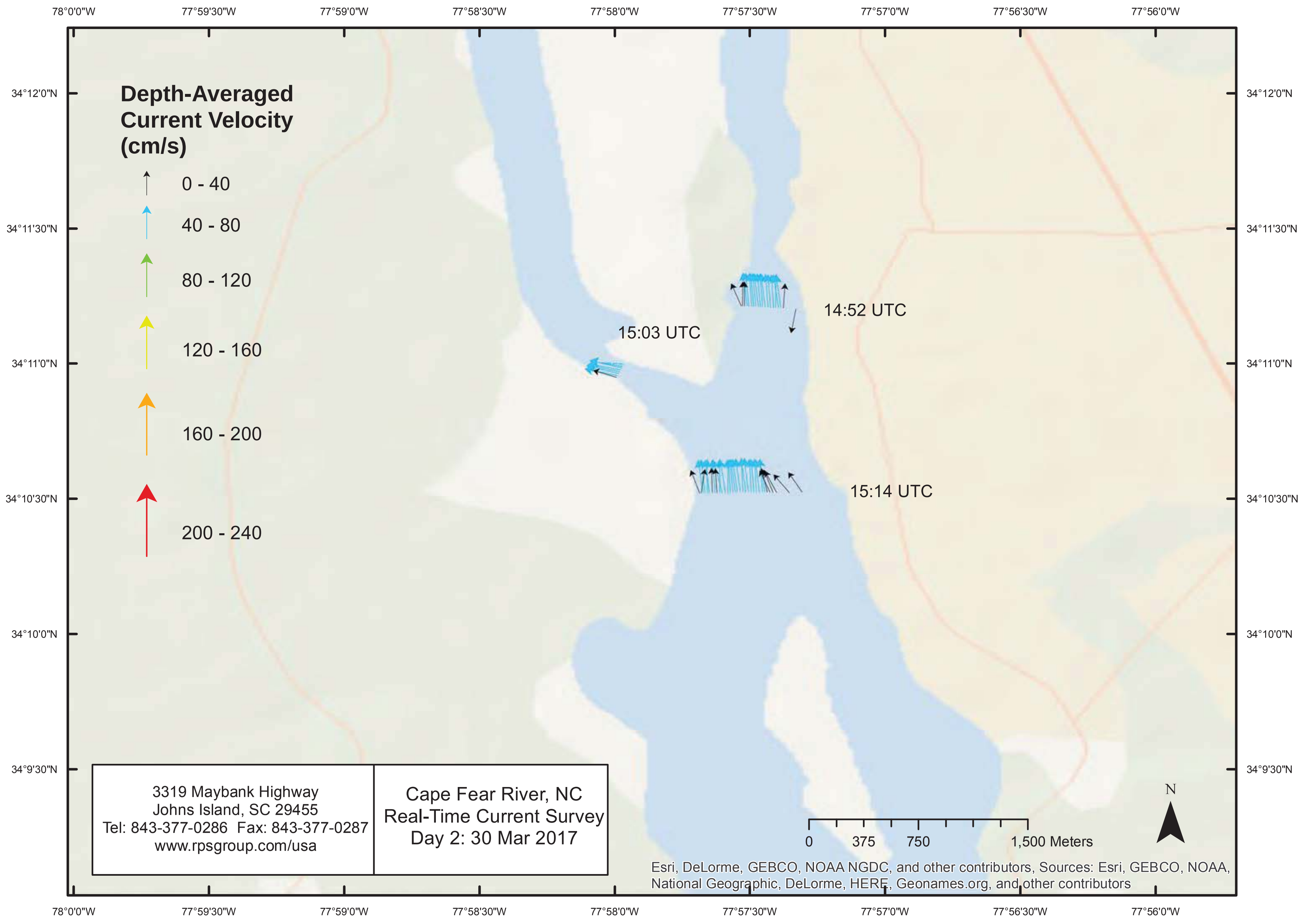

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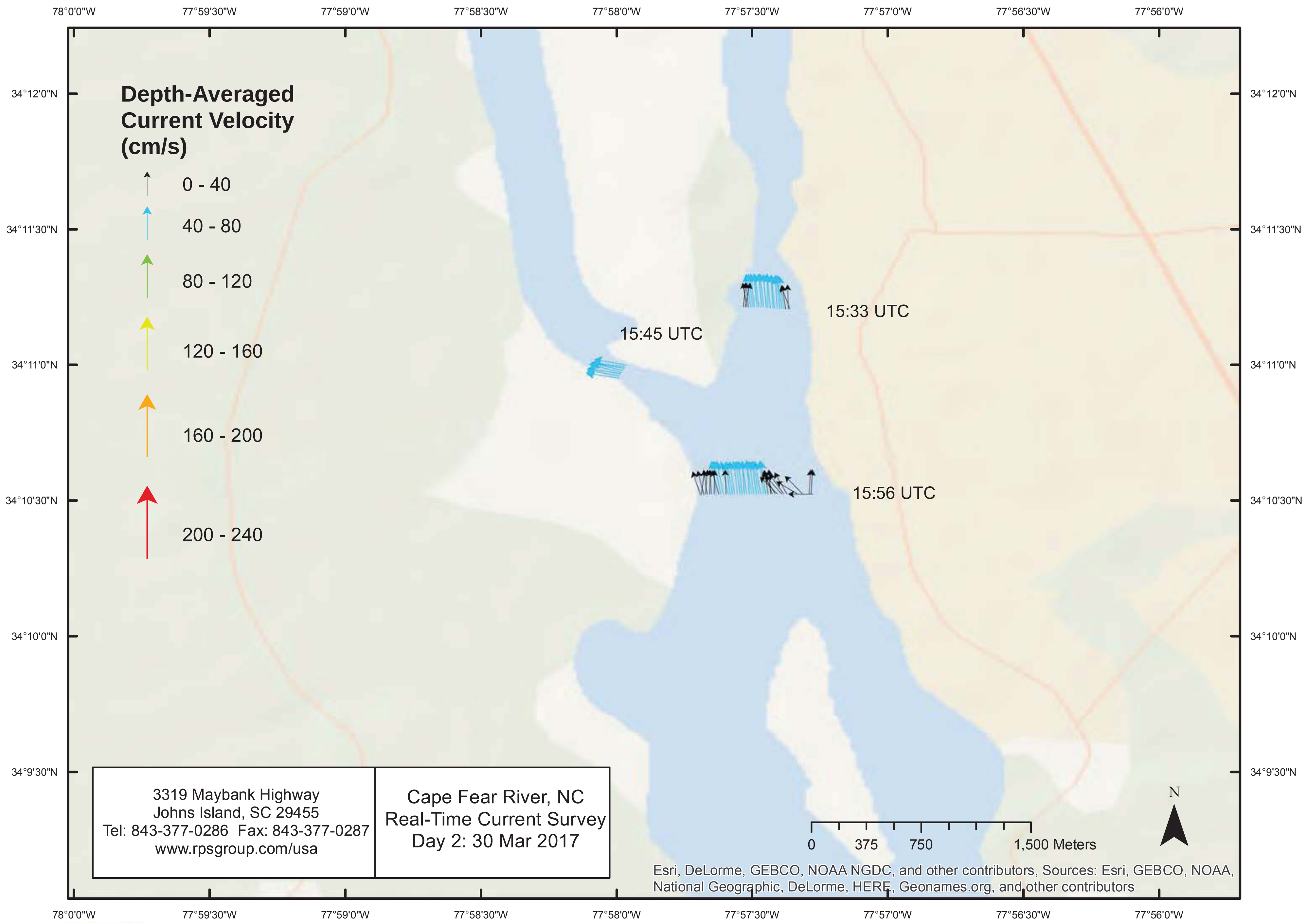

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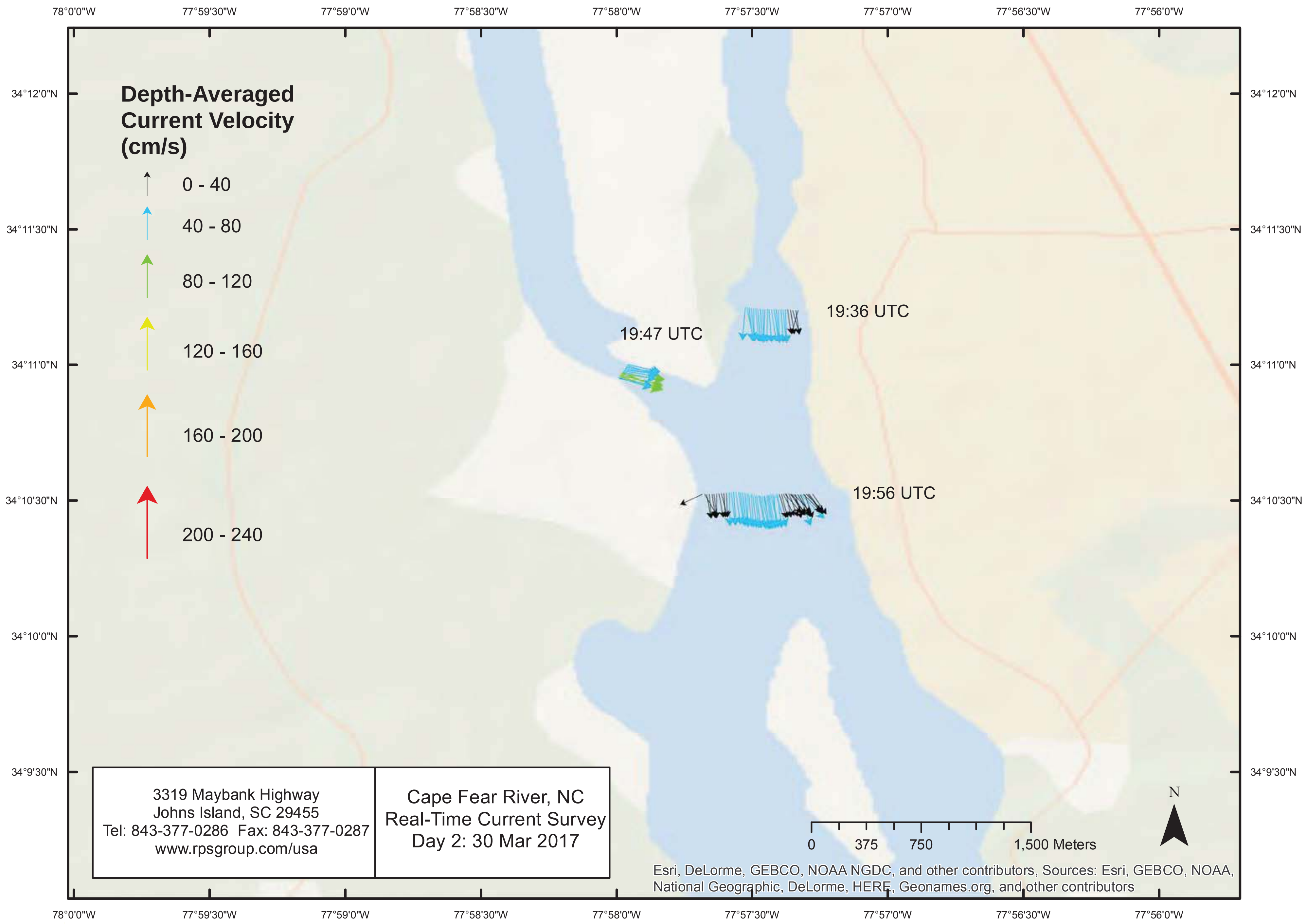

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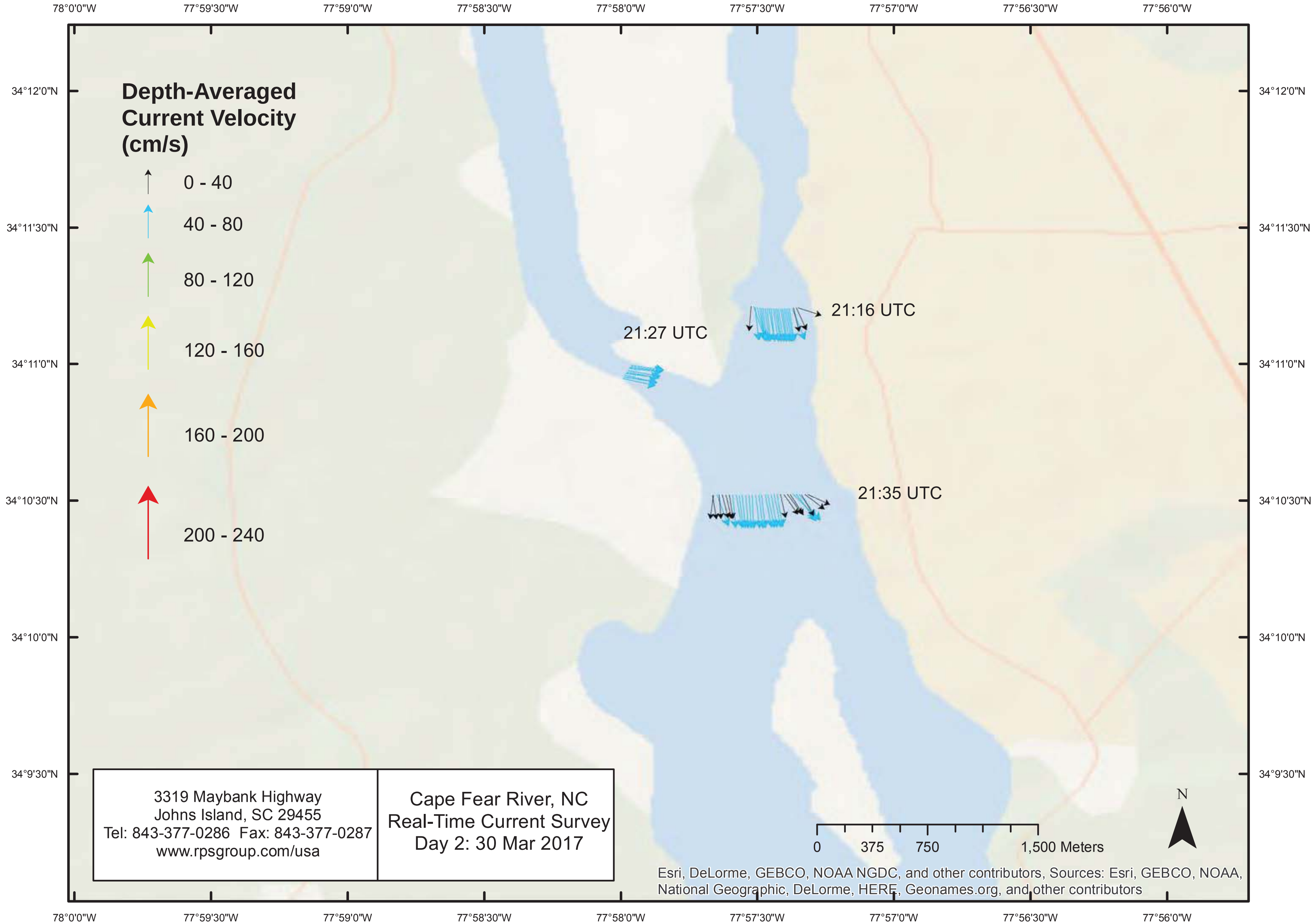

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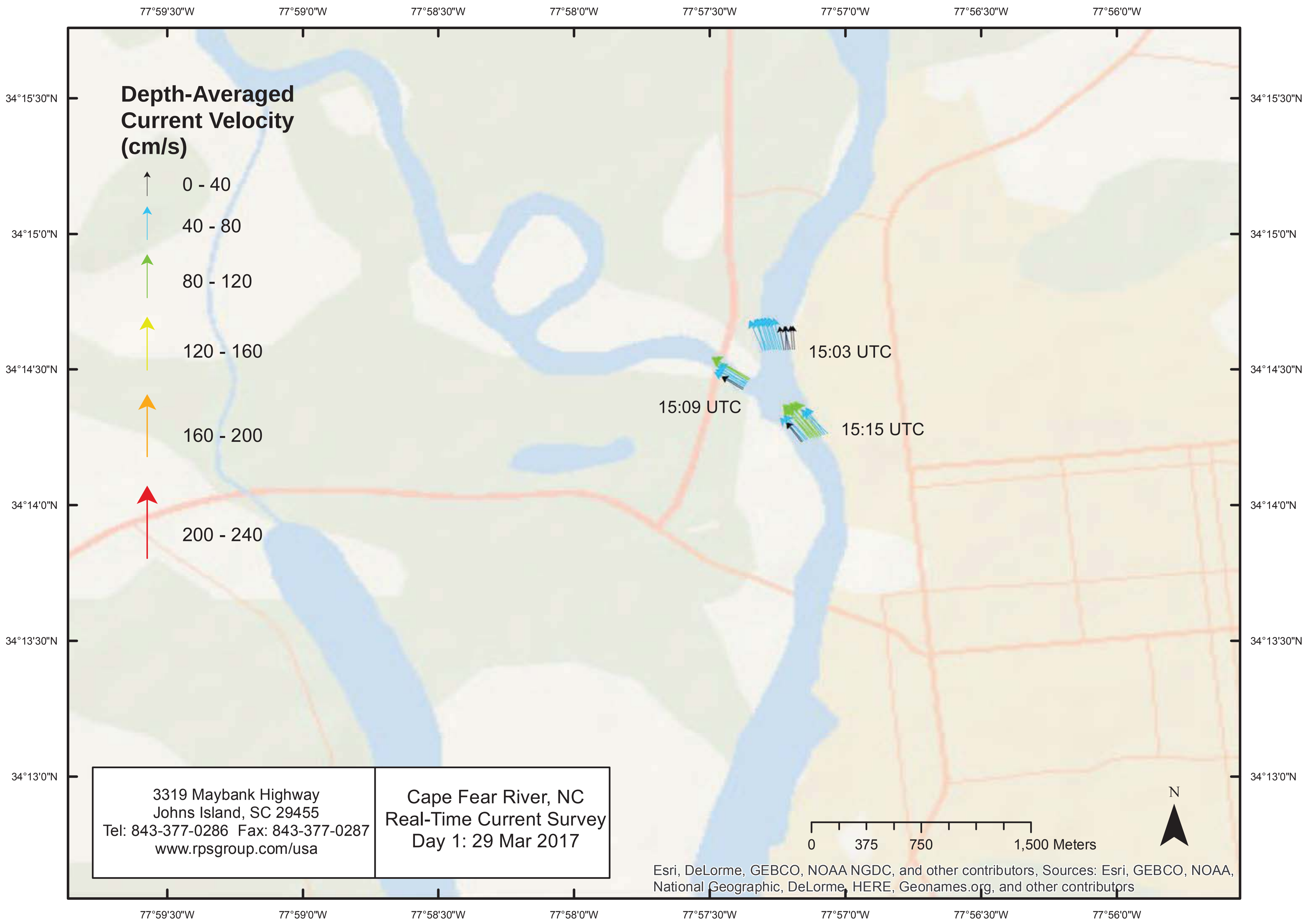
Wilmington
Downtown



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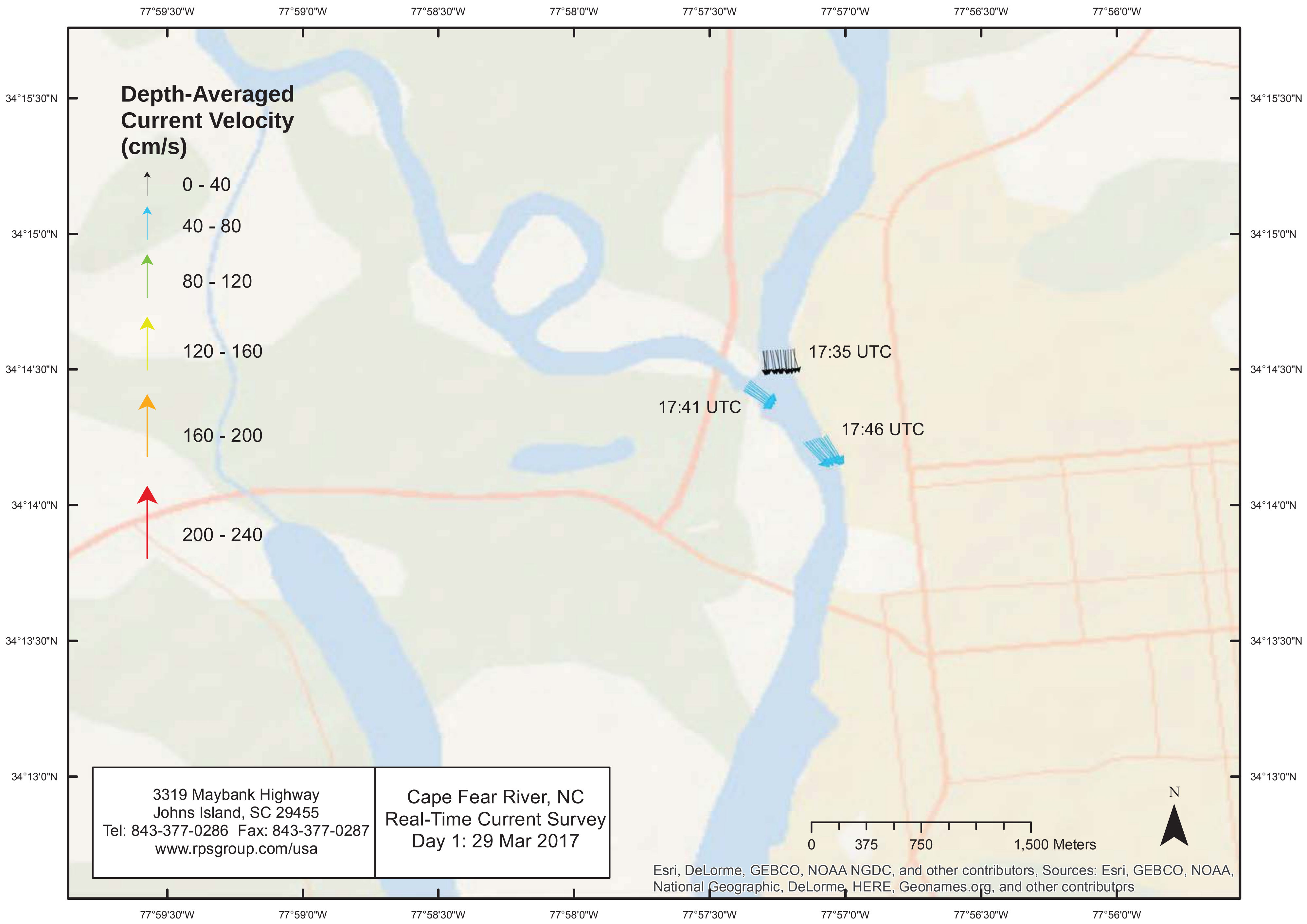

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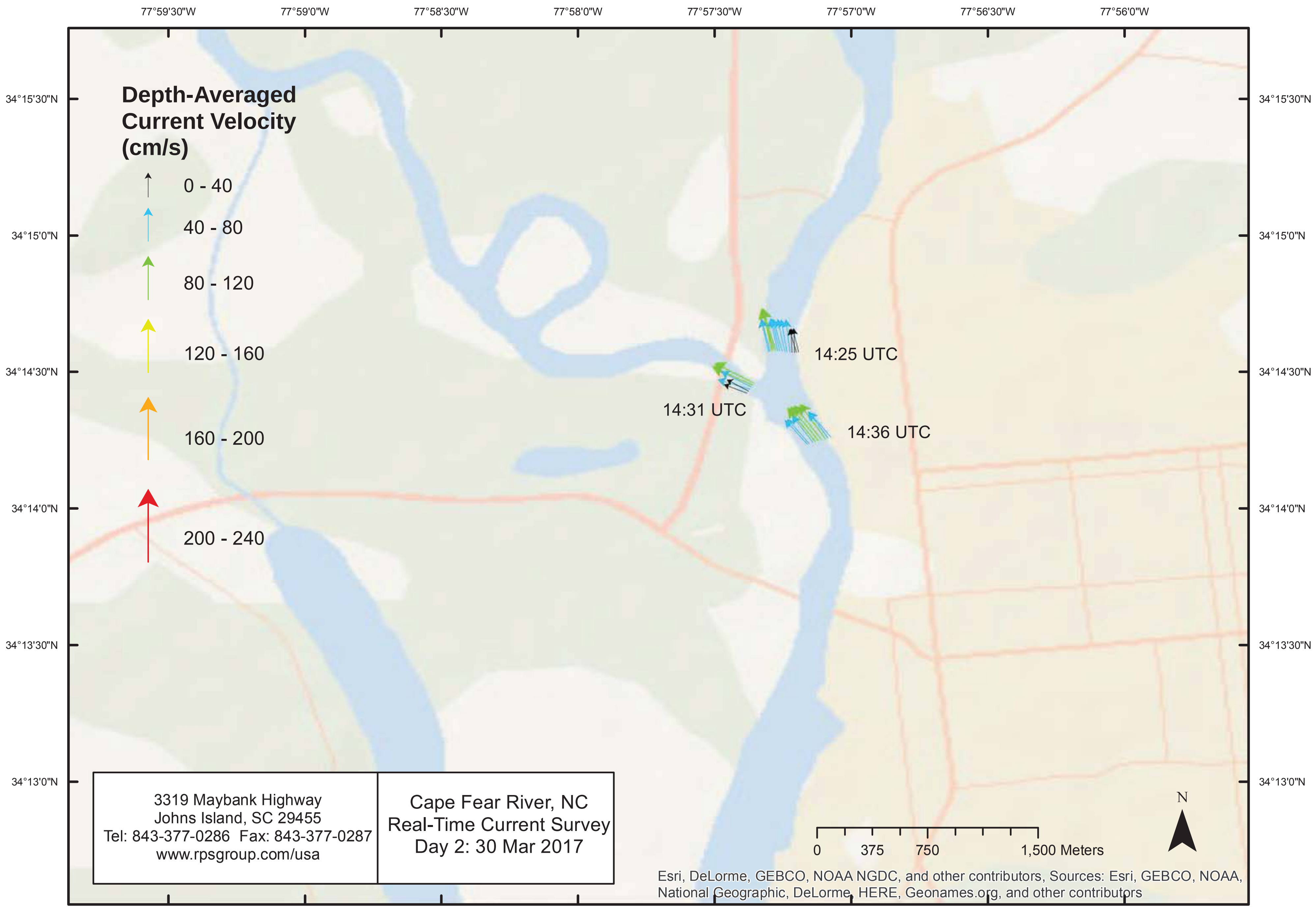

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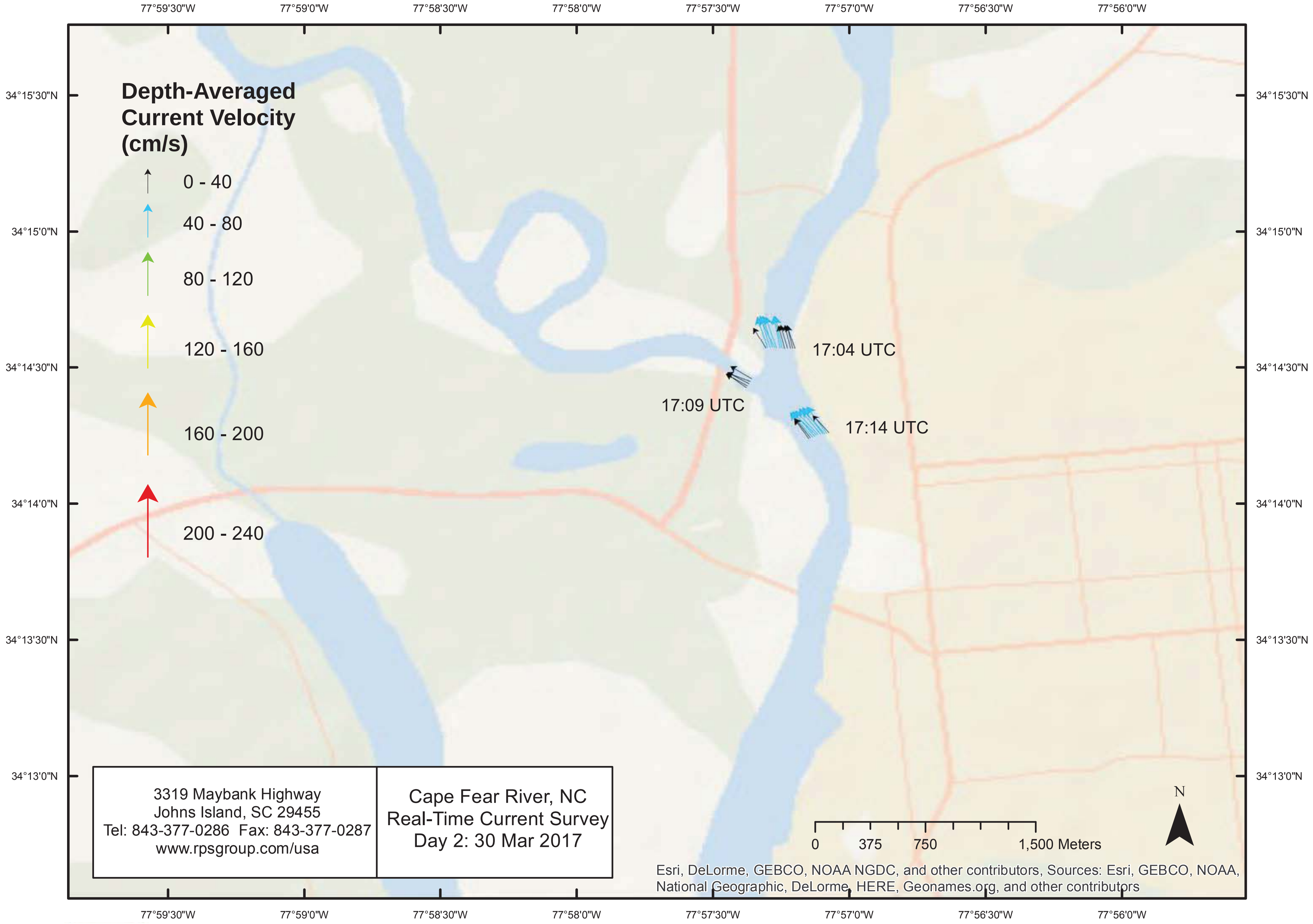

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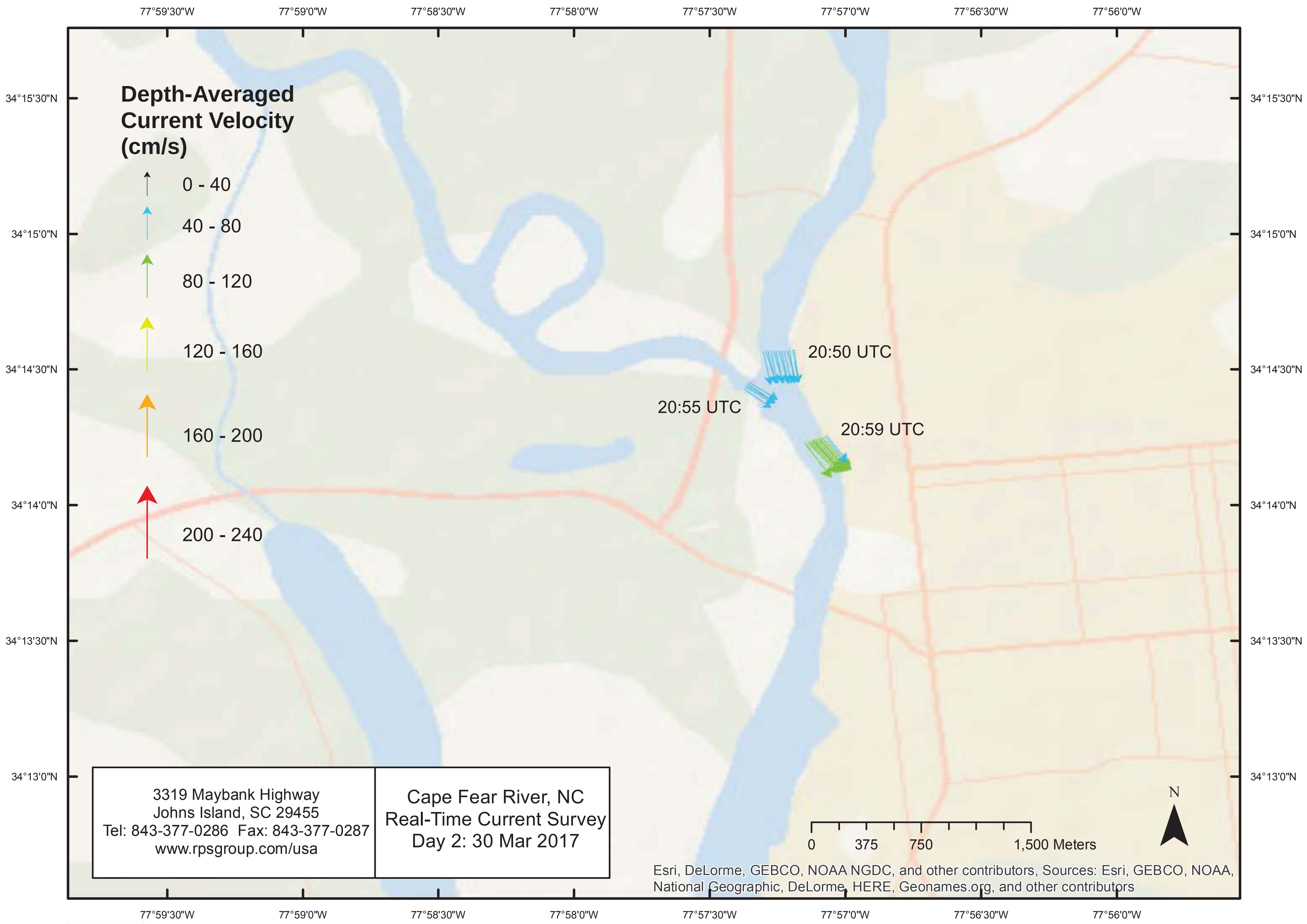

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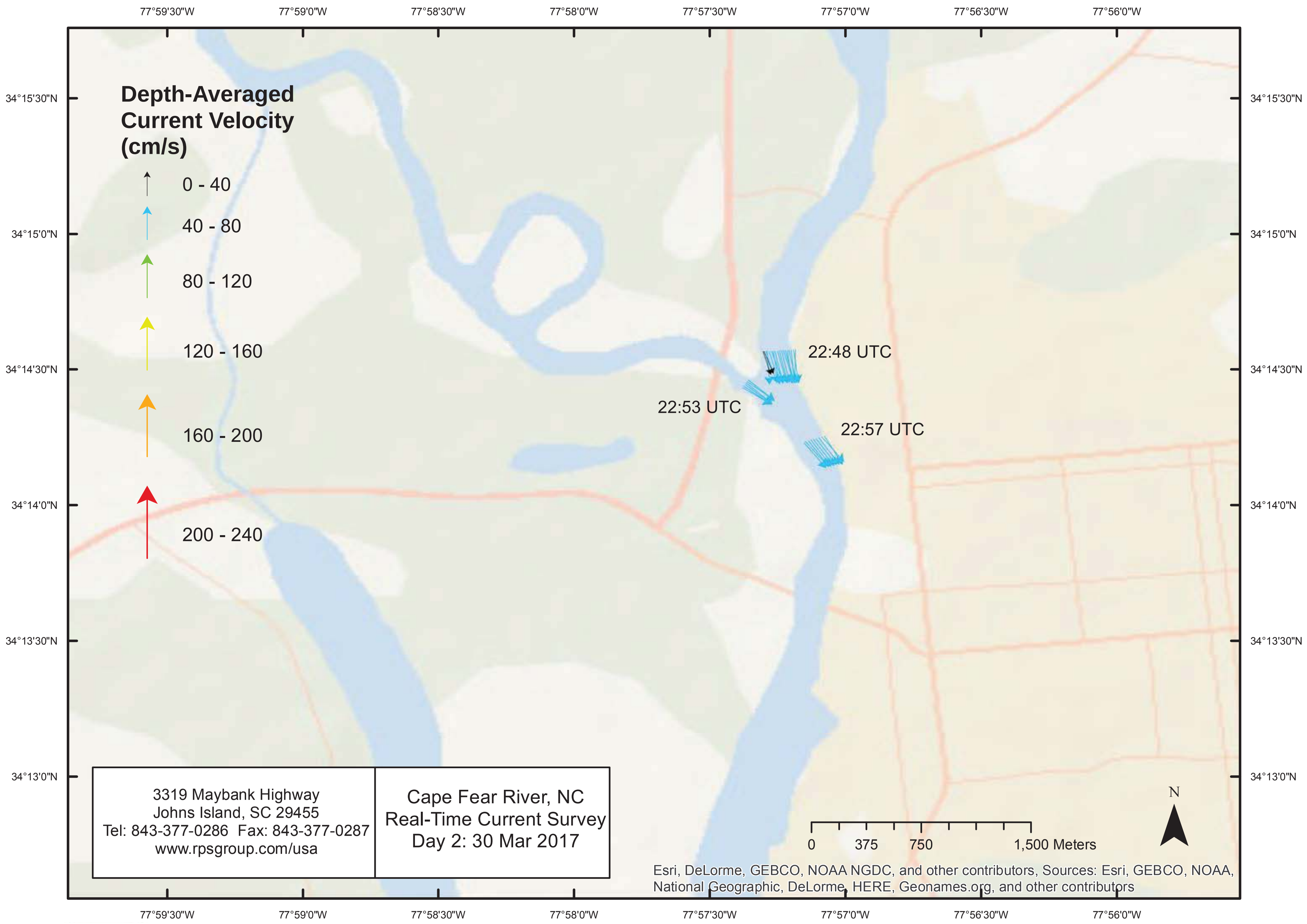

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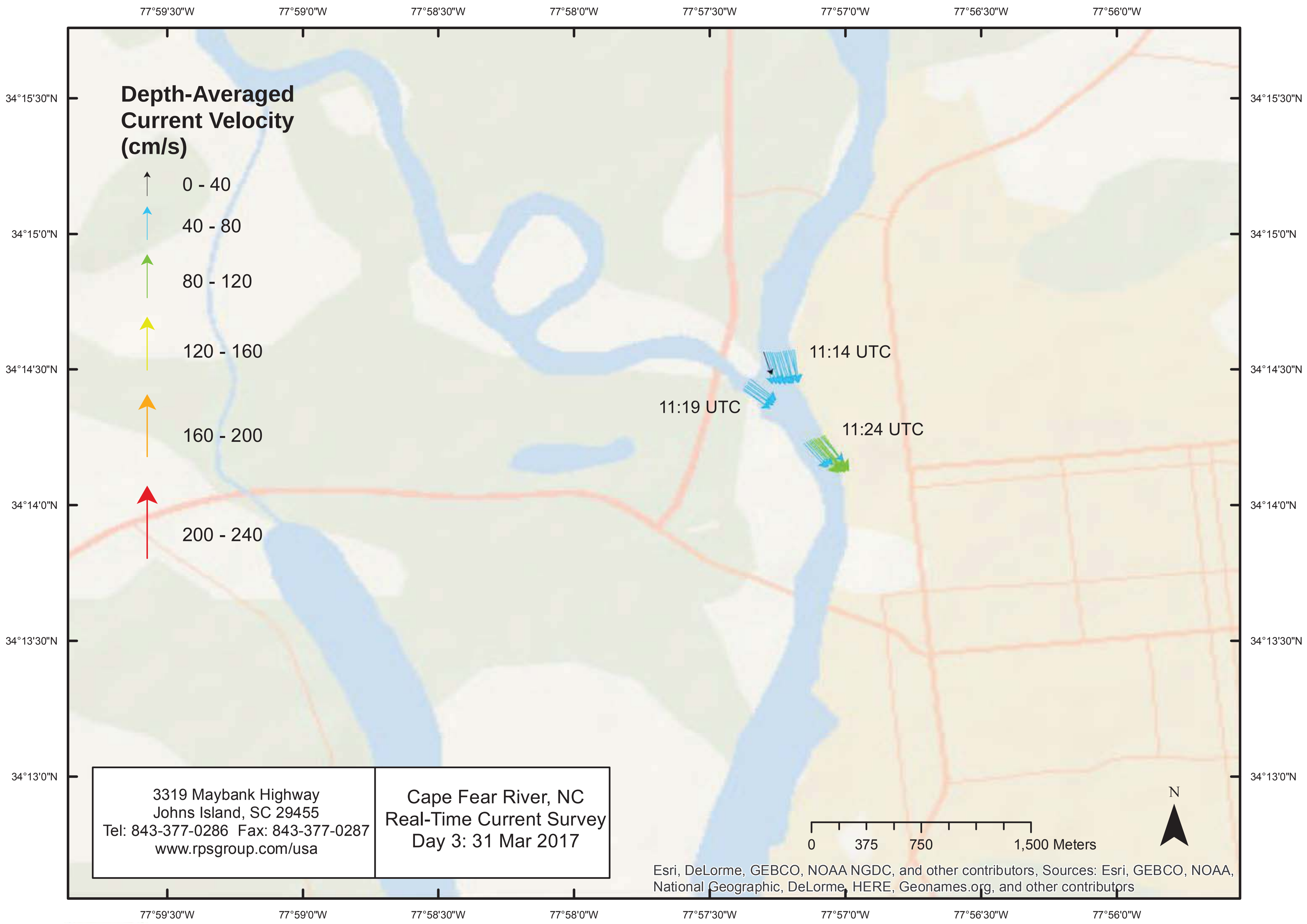

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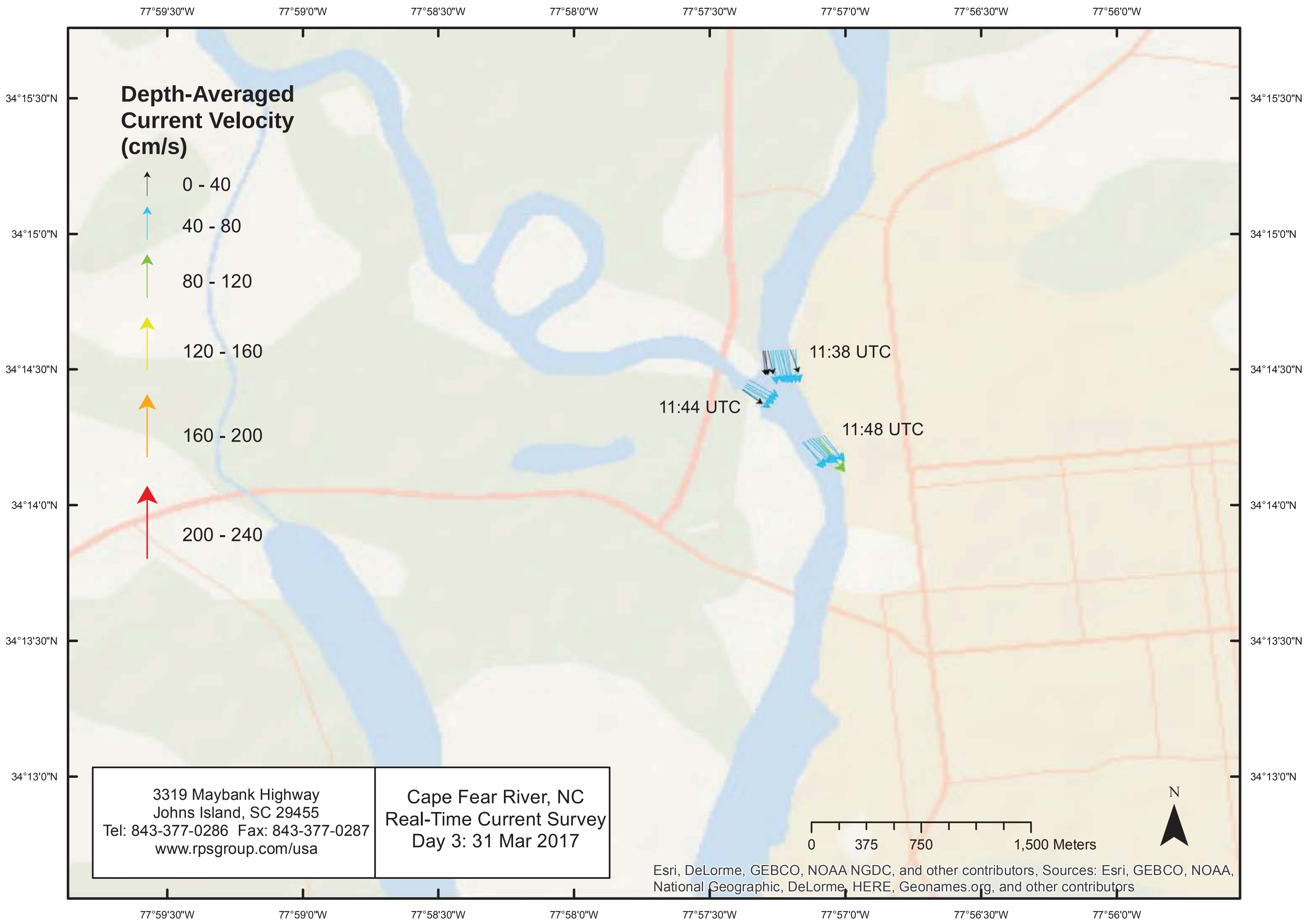

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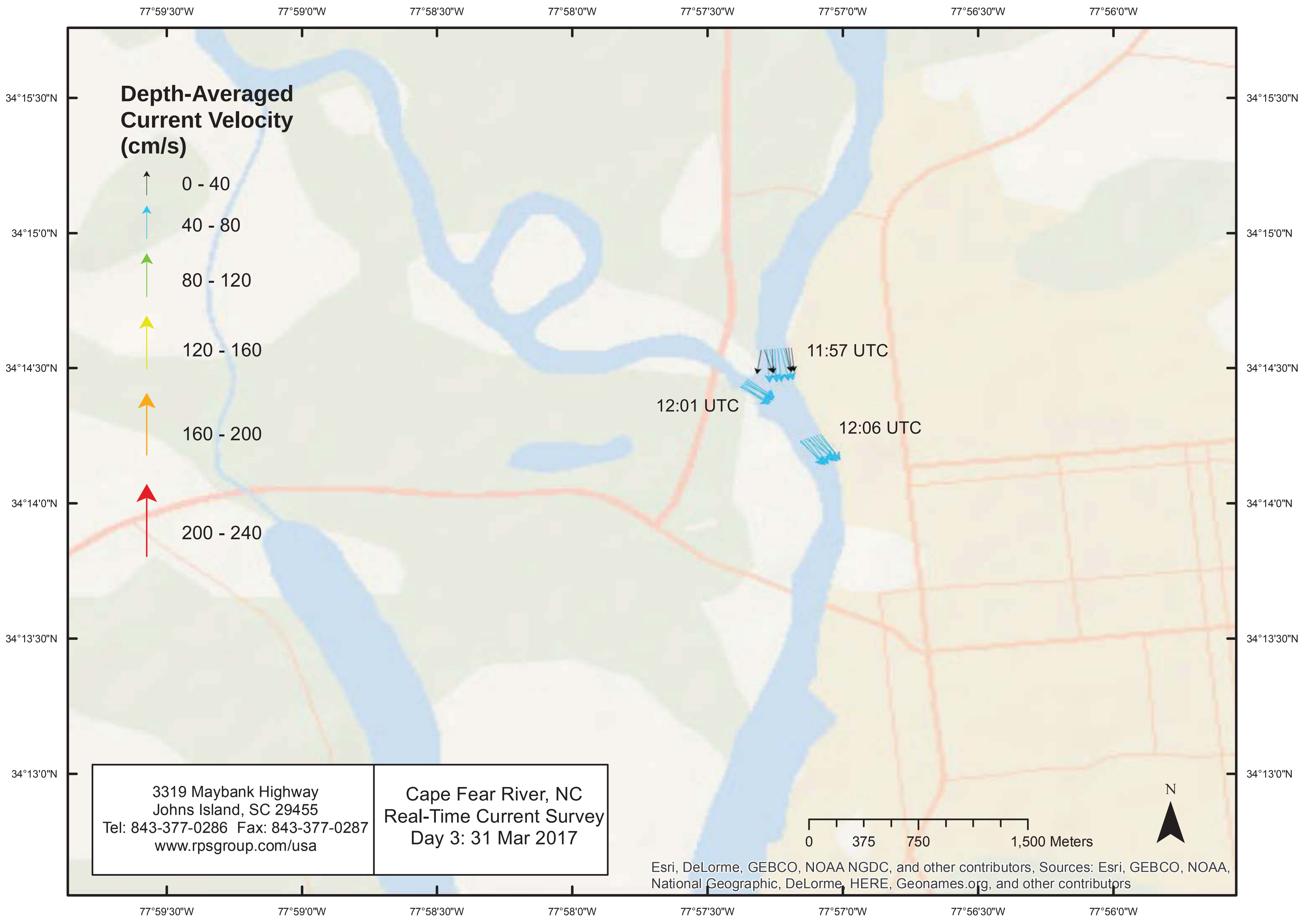

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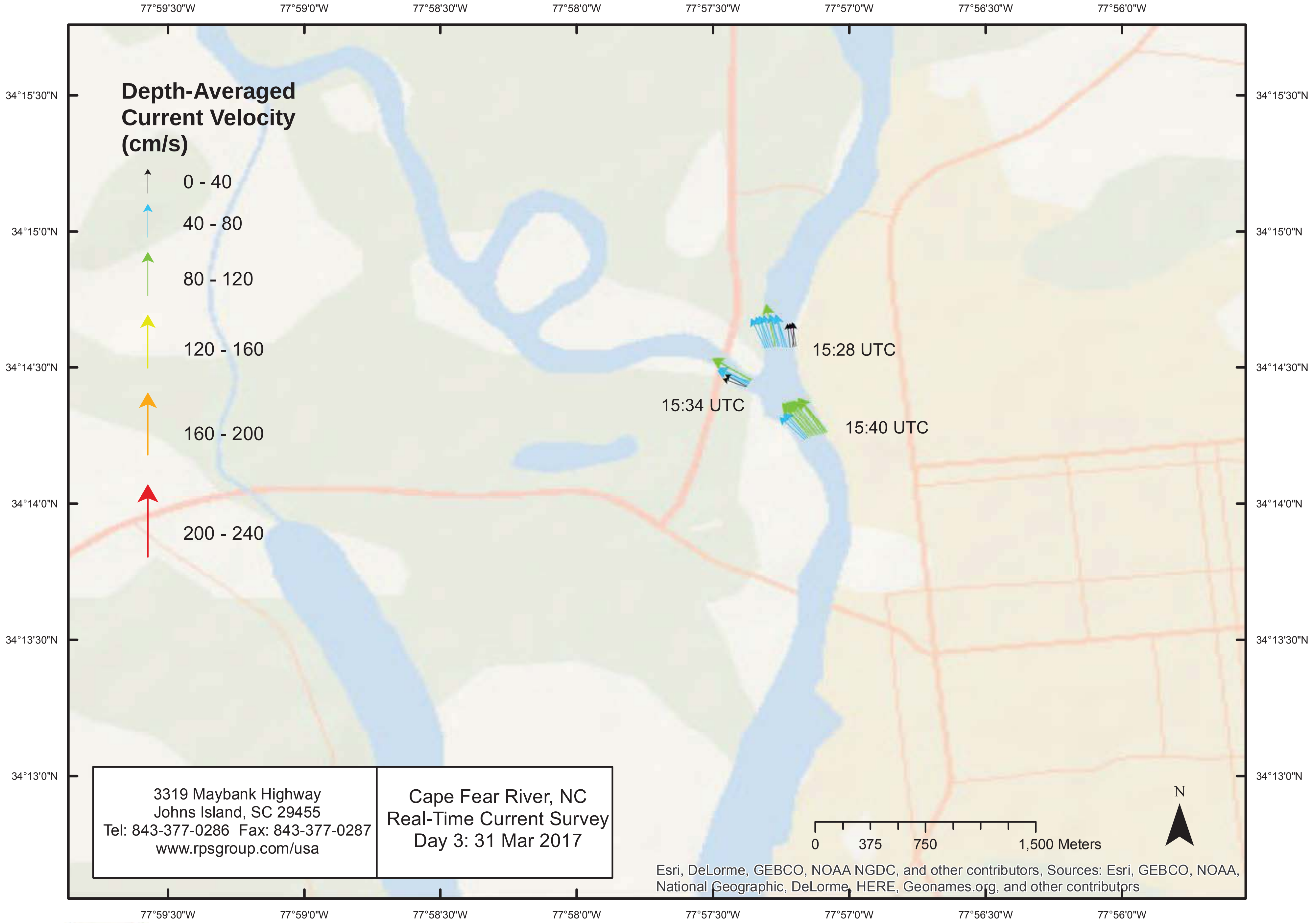

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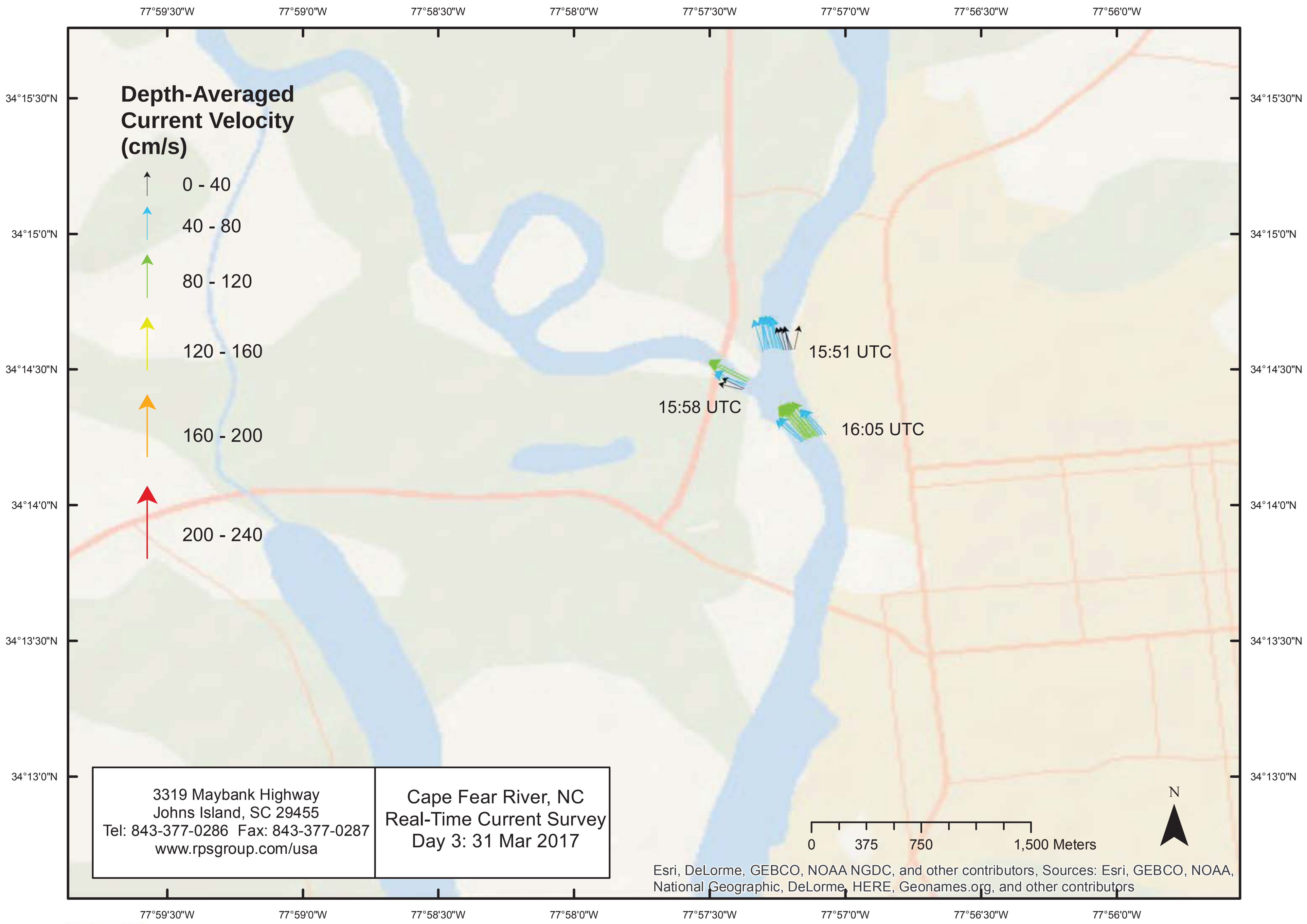

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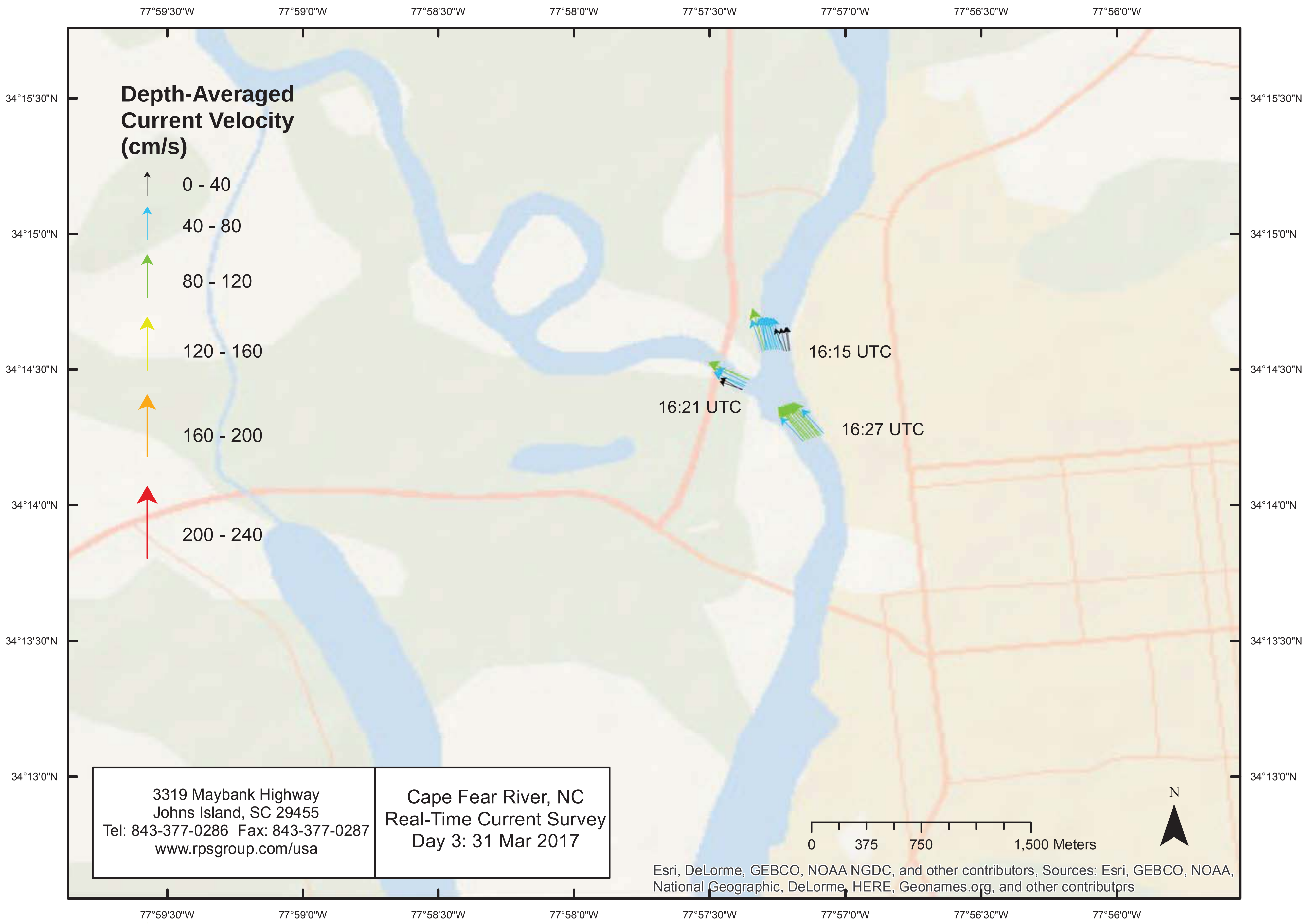

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Real-Time Current Survey
Day 3: 31 Mar 2017

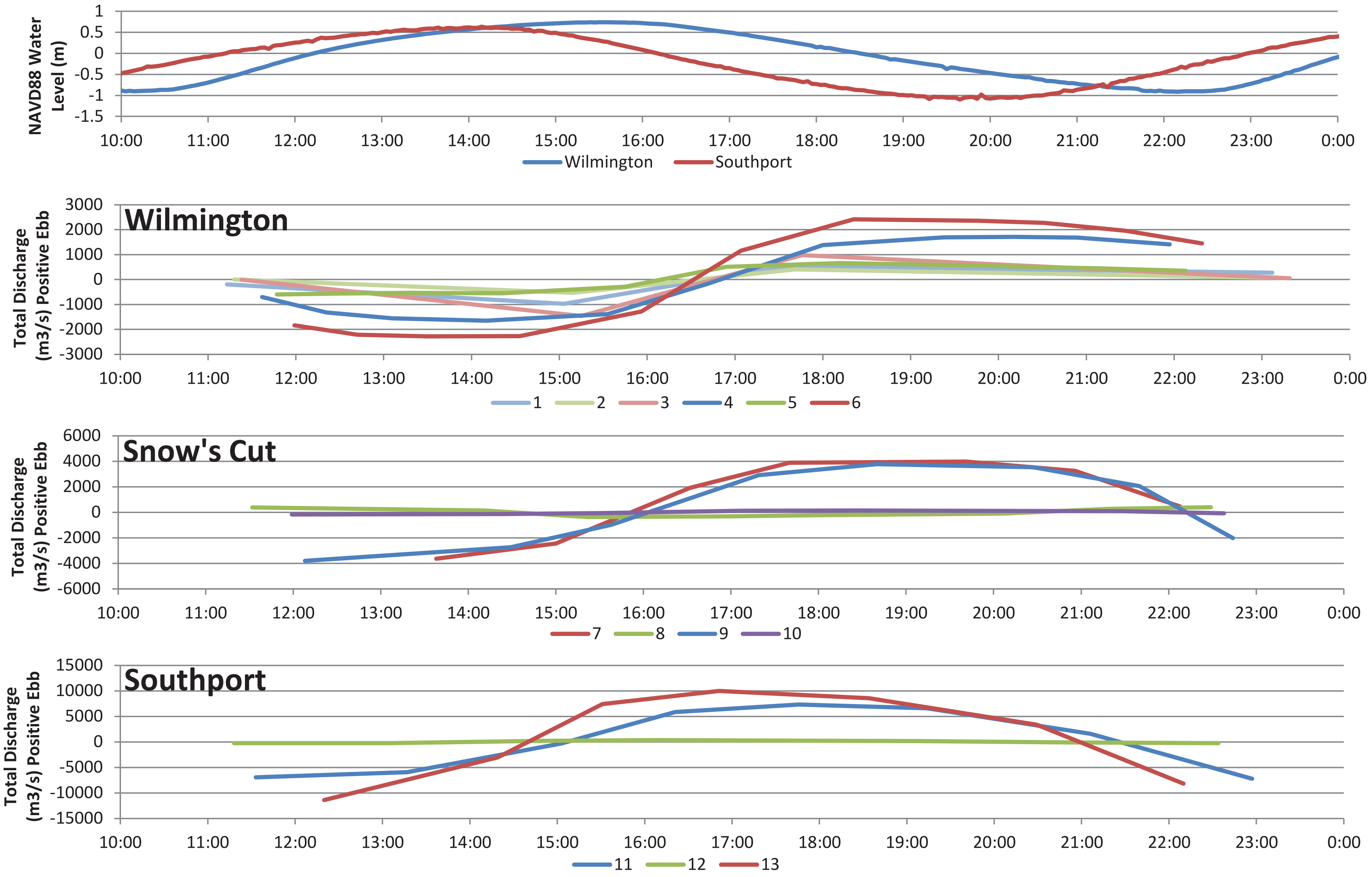
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors, Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

APPENDIX VII Discharge Plots

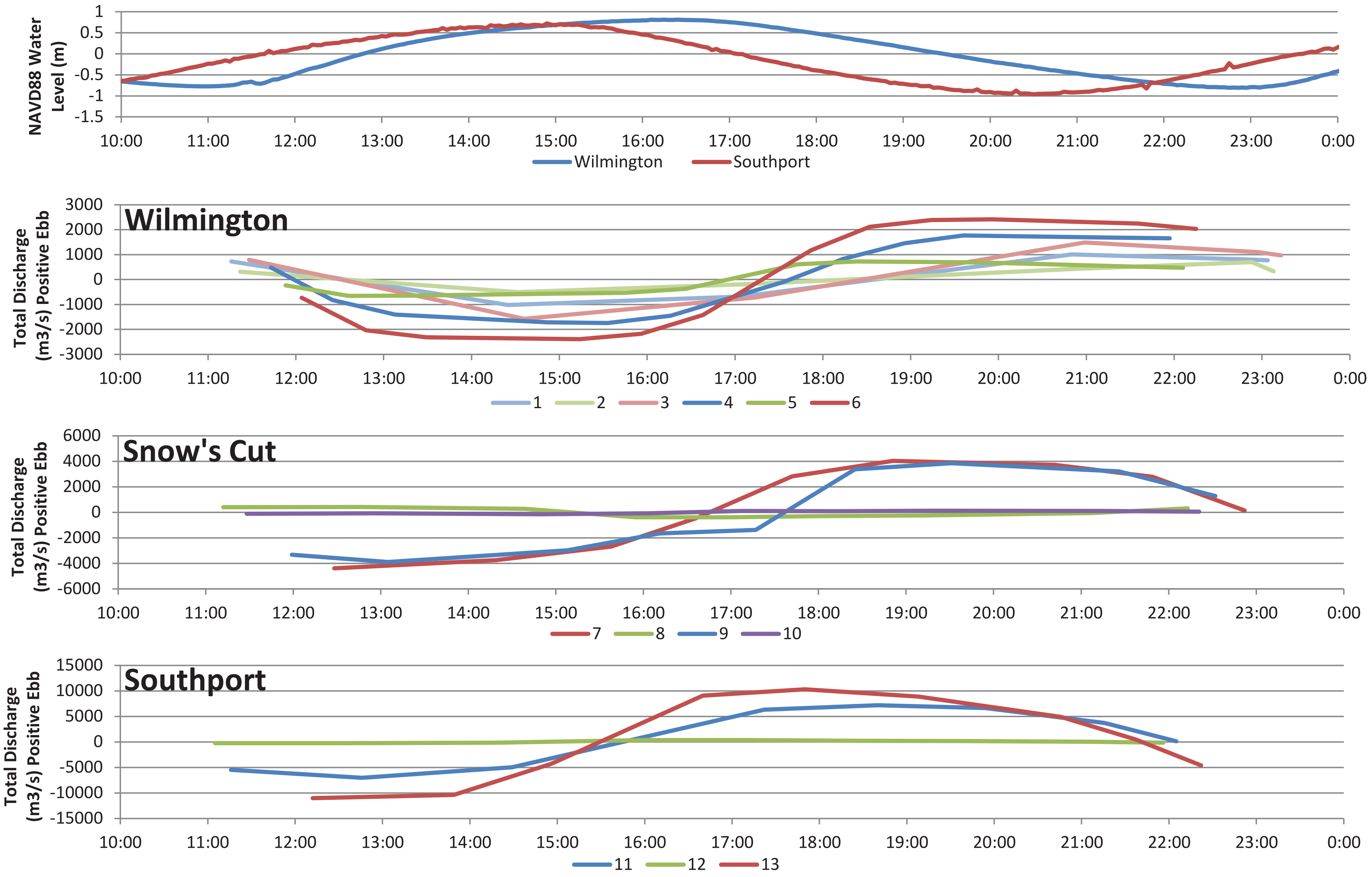
Cape Fear Vessel Mounted ADCP Current Survey - 3/29/2017

Discharge Measurements



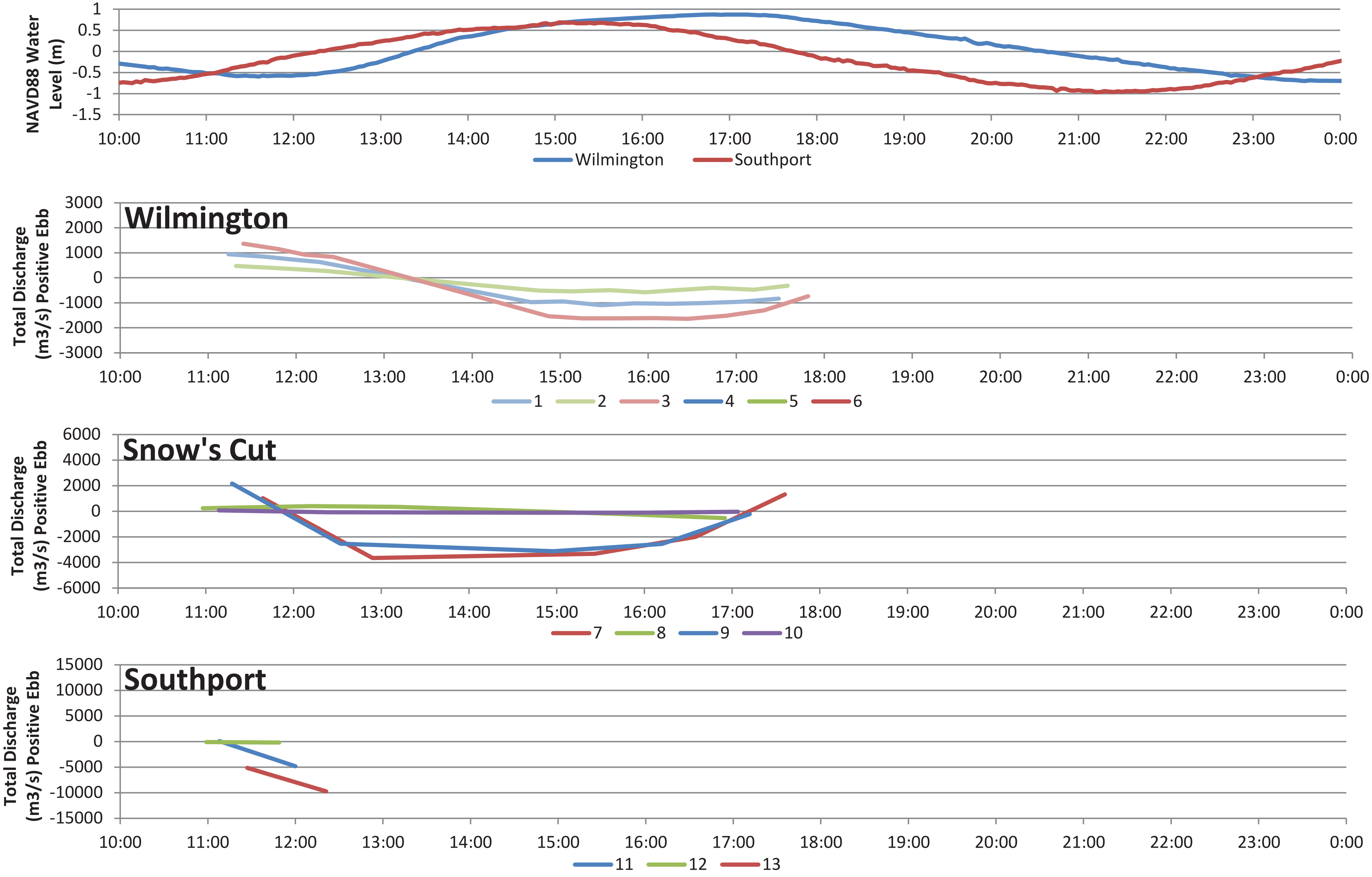
Cape Fear Vessel Mounted ADCP Current Survey - 3/30/2017

Discharge Measurements



Cape Fear Vessel Mounted ADCP Current Survey - 3/31/2017

Discharge Measurements



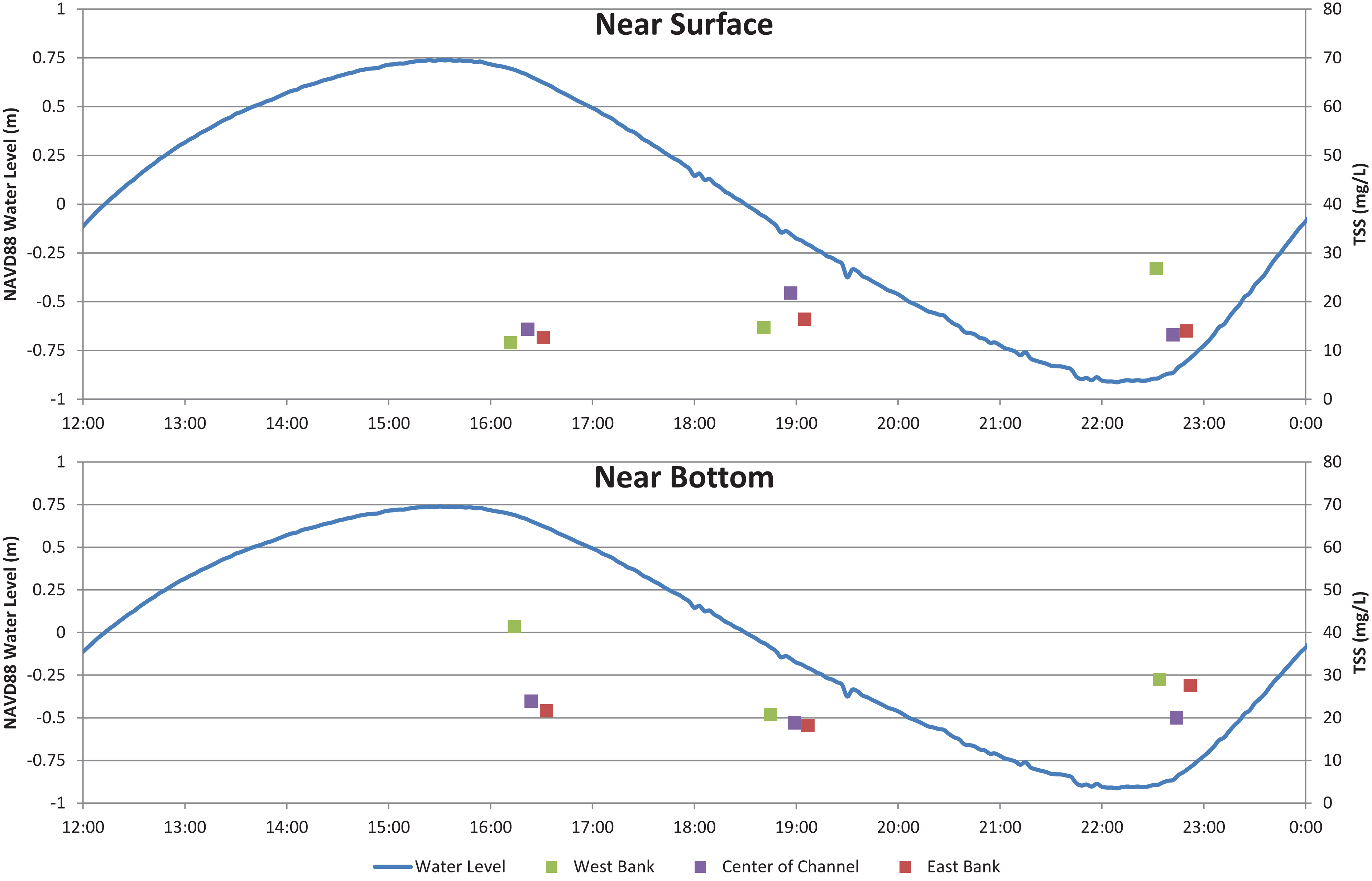
APPENDIX VIII Vessel Mounted Current Survey Water Sample Results

Lab Sample ID	Date	Time	Line	Bank	Depth	FNU	TSS (mg/L)
WH1	3/29/2017	16:12	6	Right	3.5	5.4	11.6
WH2	3/29/2017	16:14	6	Right	7	17	41.4
WH3	3/29/2017	16:22	6	Center	5	5.2	14.4
WH4	3/29/2017	16:24	6	Center	10	11.8	23.9
WH5	3/29/2017	16:31	6	Left	4.25	5.6	12.7
WH6	3/29/2017	16:33	6	Left	8.5	10.4	21.6
WH7	3/29/2017	18:41	6	Right	2	7	14.6
WH8	3/29/2017	18:45	6	Right	8	8	20.8
WH9	3/29/2017	18:57	6	Center	5	9.9	21.8
WH10	3/29/2017	18:59	6	Center	10	5.8	18.8
WH11	3/29/2017	19:05	6	Left	4	4.12	16.4
WH12	3/29/2017	19:07	6	Left	8	8.9	18.2
WH13	3/29/2017	22:32	6	Right	4	9.95	26.8
WH14	3/29/2017	22:34	6	Right	8	13	29
WH15	3/29/2017	22:42	6	Center	4	7.35	13.2
WH16	3/29/2017	22:44	6	Center	8	9.9	20
WH17	3/29/2017	22:50	6	Left	4	7.6	14
WH18	3/29/2017	22:52	6	Left	8	9.05	27.6
WH19	3/30/2017	13:41	6	Right	4	9.4	18.8
WH20	3/30/2017	13:44	6	Right	8	11.4	25.4
WH21	3/30/2017	13:52	6	Center	5	7.3	17.8
WH22	3/30/2017	13:54	6	Center	10	13.3	31
WH23	3/30/2017	13:58	6	Center	14	16	79
WH24	3/30/2017	14:09	6	Left	4	12.9	28.4
WH25	3/30/2017	14:11	6	Left	8	11	27
WH26	3/30/2017	20:10	6	Right	3	12.2	26.4
WH27	3/30/2017	20:14	6	Right	7	26	62.7
WH30	3/30/2017	20:21	6	Center	13	15.75	17.8
WH28	3/30/2017	20:24	6	Center	5	7.85	24.4
WH29	3/30/2017	20:26	6	Center	9	8.15	34.4
WH31	3/30/2017	20:33	6	Left	4	5.2	9.4
WH32	3/30/2017	20:36	6	Left	8	7.4	19.8
SC1	3/29/2017	12:50	9	Left	1	6.9	16
SC2	3/29/2017	13:00	9	Left	2	7	22
SC3	3/29/2017	13:06	9	Center	5	8	22
SC4	3/29/2017	13:09	9	Center	10	9.2	25.2
SC5	3/29/2017	13:18	9	Right	1	6.3	13.4
SC6	3/29/2017	13:20	9	Right	2	6.7	15.8
SC7	3/29/2017	15:55	9	Left	1	4.8	9.8
SC8	3/29/2017	15:58	9	Left	2	4.8	12.4
SC9	3/29/2017	16:03	9	Center	5	5.25	11.6
SC10	3/29/2017	16:08	9	Center	10	7.7	25.6
SC11	3/29/2017	16:11	9	Right	1	5.4	13.4
SC12	3/29/2017	16:14	9	Right	2	10.6	17.6

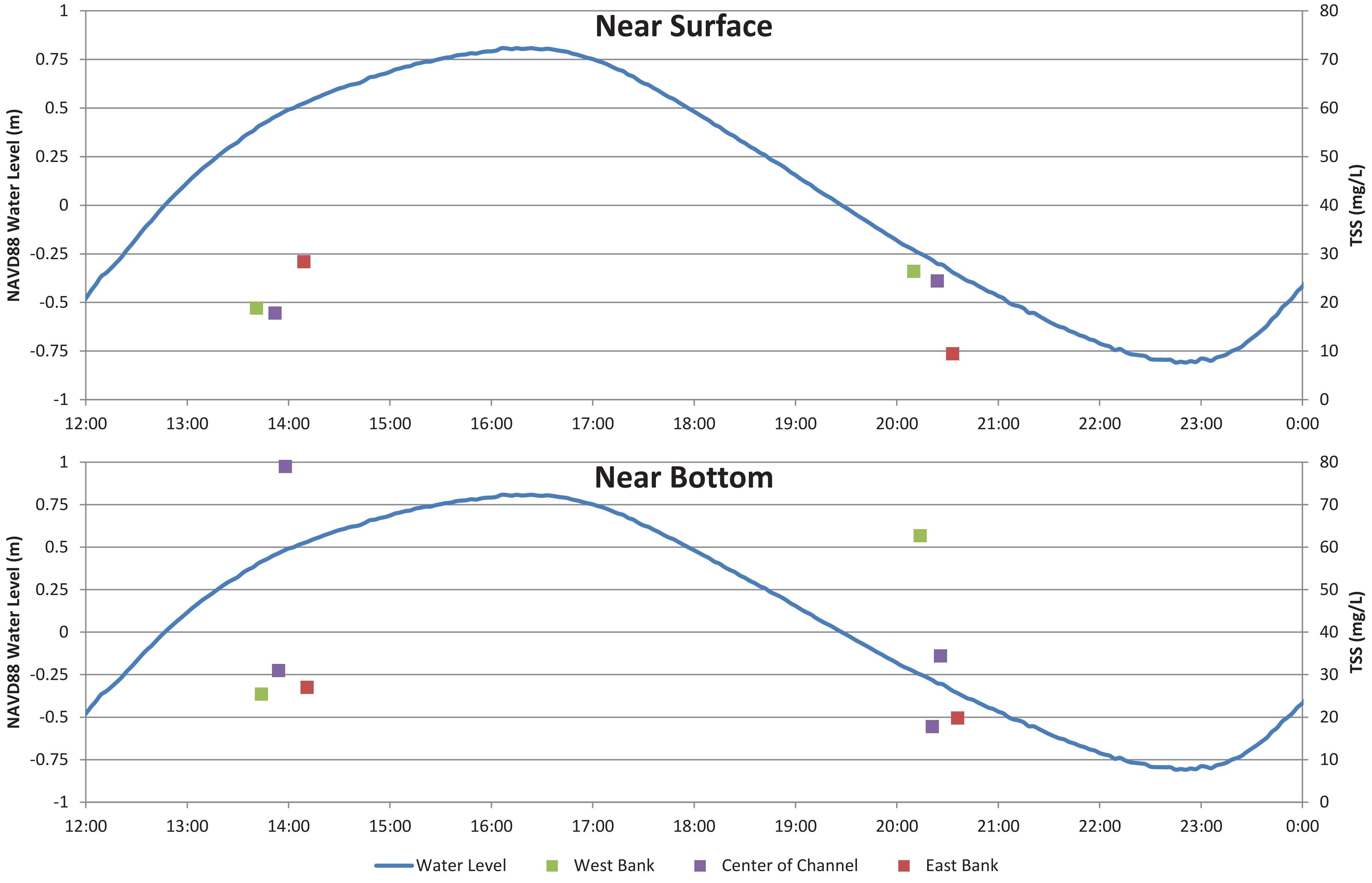
Lab Sample ID	Date	Time	Line	Bank	Depth	FNU	TSS (mg/L)
SC13	3/29/2017	19:01	9	Left	4	10.4	25.6
SC14	3/29/2017	19:04	9	Left	8	11.4	25.2
SC15	3/29/2017	19:08	9	Center	5	12	33.6
SC16	3/29/2017	19:11	9	Center	10	14.4	38.8
SC17	3/29/2017	19:17	9	Right	4	14	37.2
SC18	3/29/2017	19:23	9	Right	8	18.4	65.6
SC19	3/30/2017	13:25	9	Left	4	7.2	14
SC20	3/30/2017	13:29	9	Left	8	16.1	39.2
SC21	3/30/2017	13:33	9	Center	5	8.8	22.4
SC22	3/30/2017	13:36	9	Center	10	17.1	40.4
SC23	3/30/2017	13:40	9	Center	15	23.5	53
SC24	3/30/2017	14:01	9	Right	4	5.9	13.8
SC25	3/30/2017	14:05	9	Right	8	25	58
SC26	3/30/2017	19:50	9	Left	4	8.4	17.2
SC27	3/30/2017	19:52	9	Left	8	11.6	25.6
SC28	3/30/2017	20:05	9	Center	5	10.5	24.8
SC29	3/30/2017	20:09	9	Center	10	12	32.4
SC30	3/30/2017	20:12	9	Center	15	17.5	60
SC31	3/30/2017	20:20	9	Left	4	6.1	16
SC32	3/30/2017	20:23	9	Left	8	7.4	15.6
SP1	3/29/2017	13:33	11	Right	2	10.4	25.4
SP2	3/29/2017	13:36	11	Right	4	11.8	30.4
SP3	3/29/2017	13:45	11	Center	4	9.4	23.6
SP4	3/29/2017	13:50	11	Center	8	13	36
SP5	3/29/2017	13:56	11	Left	4	8.2	19.6
SP6	3/29/2017	13:59	11	Left	8	8.75	20.4
SP7	3/29/2017	19:41	11	Left	4	8.6	16.4
SP8	3/29/2017	19:47	11	Left	8	5.87	18.8
SP9	3/29/2017	19:56	11	Center	4	8	18.8
SP10	3/29/2017	20:00	11	Center	8	8.5	18
SP11	3/29/2017	20:10	11	Right	2	7.5	19.2
SP12	3/29/2017	20:13	11	Right	4	10.5	22.4
SP13	3/29/2017	21:26	11	Left	2	6.25	13.6
SP14	3/29/2017	21:32	11	Left	4	6.75	17.2
SP15	3/29/2017	21:37	11	Center	4	#N/A	28
SP16	3/29/2017	21:40	11	Center	8	7.8	21.2
SP17	3/29/2017	21:48	11	Right	4	5.8	13.2
SP18	3/29/2017	21:52	11	Right	8	2	19.2
SP19	3/30/2017	13:02	11	Left	2	8.8	26
SP20	3/30/2017	13:04	11	Left	4	7.75	21.6
SP21	3/30/2017	13:18	11	Right	8	12.9	30.8
SP23	3/30/2017	15:15	11	Right	4	11.75	26
SP24	3/30/2017	15:23	11	Center	4	11.5	29
SP25	3/30/2017	15:25	11	Center	8	15.4	39.2

Lab Sample ID	Date	Time	Line	Bank	Depth	FNU	TSS (mg/L)
SP26	3/30/2017	15:28	11	Center	12	13.5	30.8
SP27	3/30/2017	20:04	11	Right	4	9.5	24
SP28	3/30/2017	20:13	11	Right	8	7.2	17.6
SP29	3/30/2017	20:23	11	Center	4	8.5	21.6
SP30	3/30/2017	20:25	11	Center	8	9.25	24.8
SP31	3/30/2017	20:30	11	Left	2	8.8	21.2
SP32	3/30/2017	20:32	11	Left	4	9.9	27.2

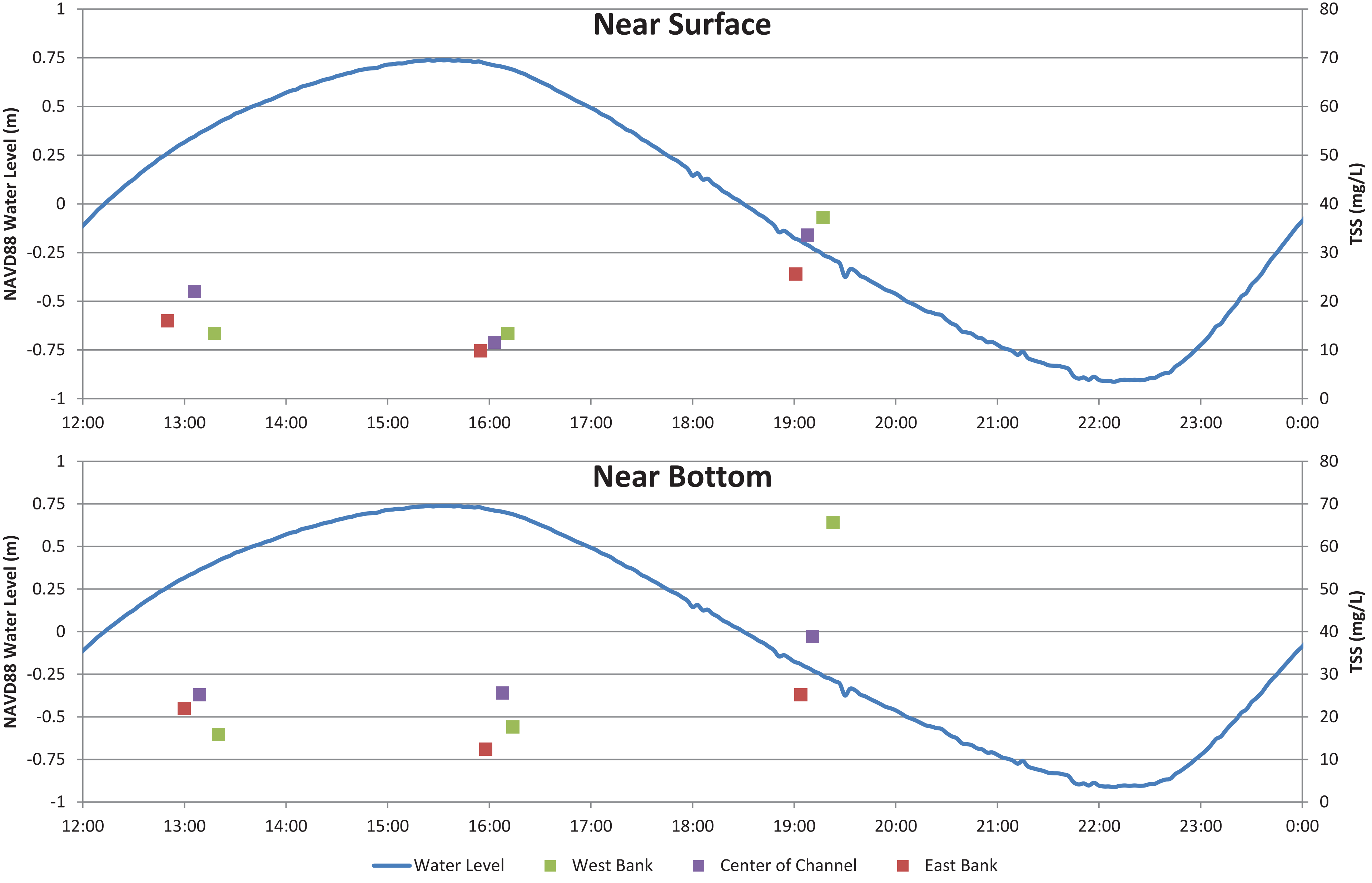
Wilmington (Transect 6) Water Samples - March 29, 2017



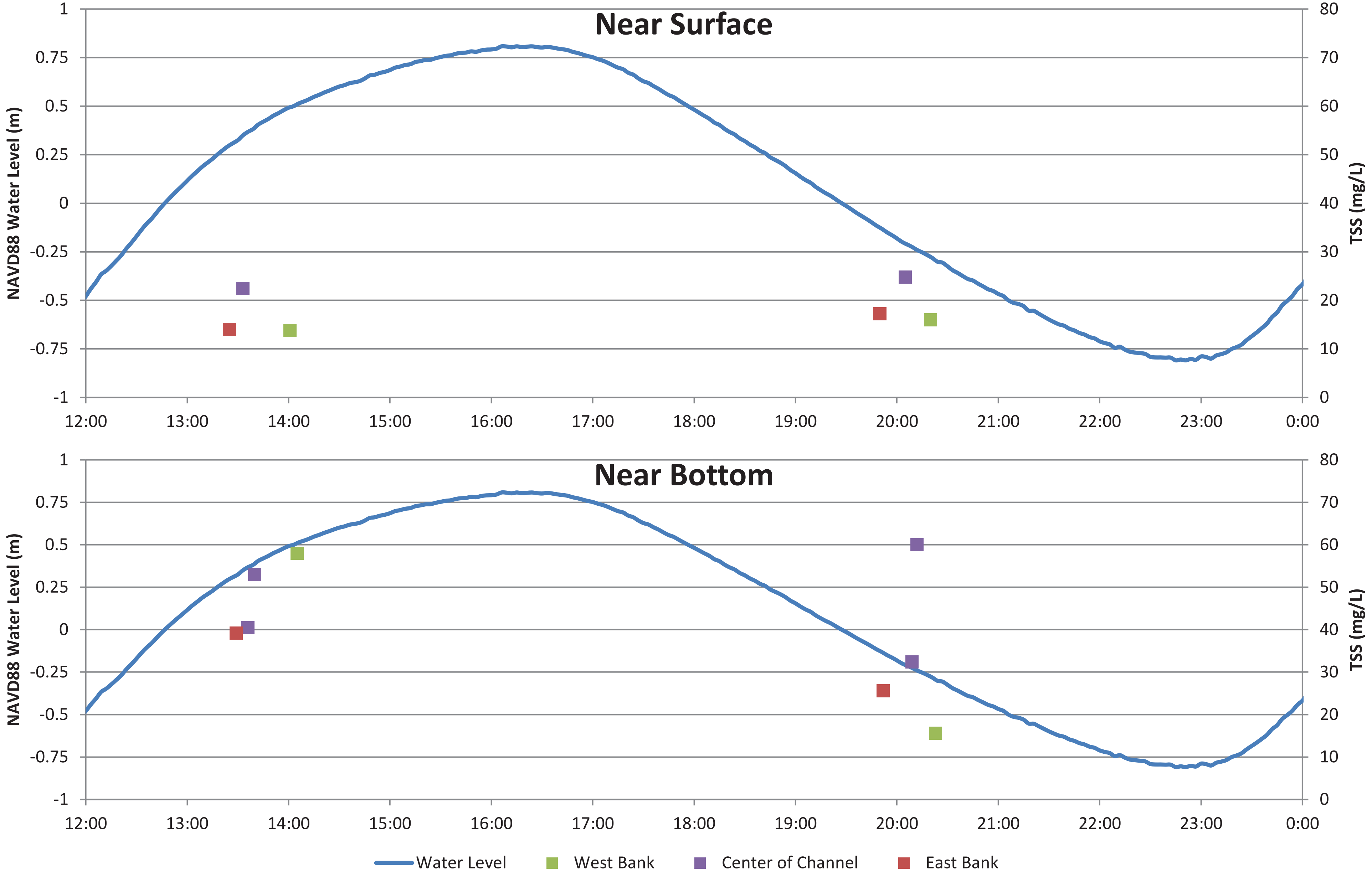
Wilmington (Transect 6) Water Samples - March 30, 2017



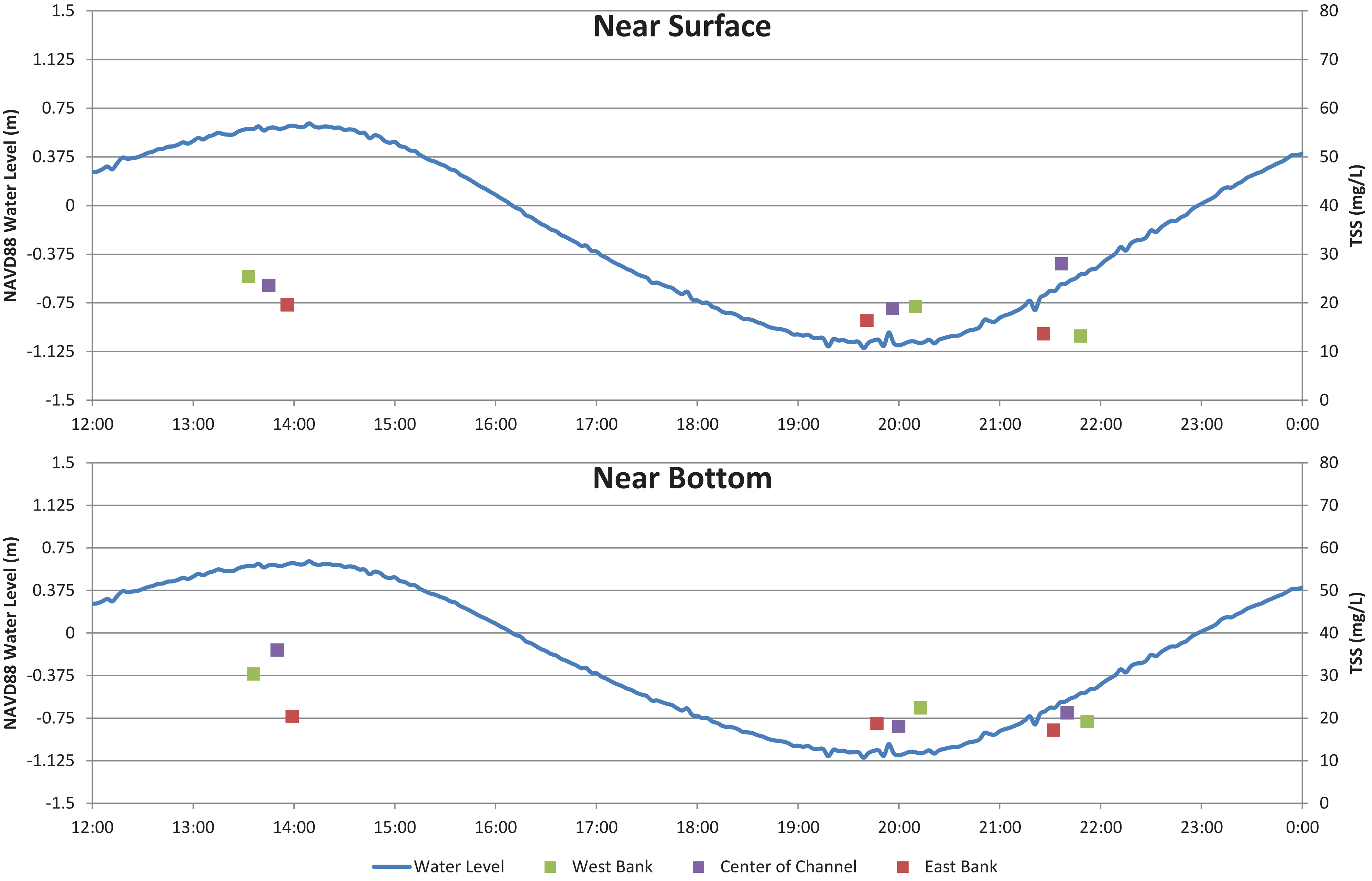
Snow's Cut (Transect 9) Water Samples - March 29, 2017



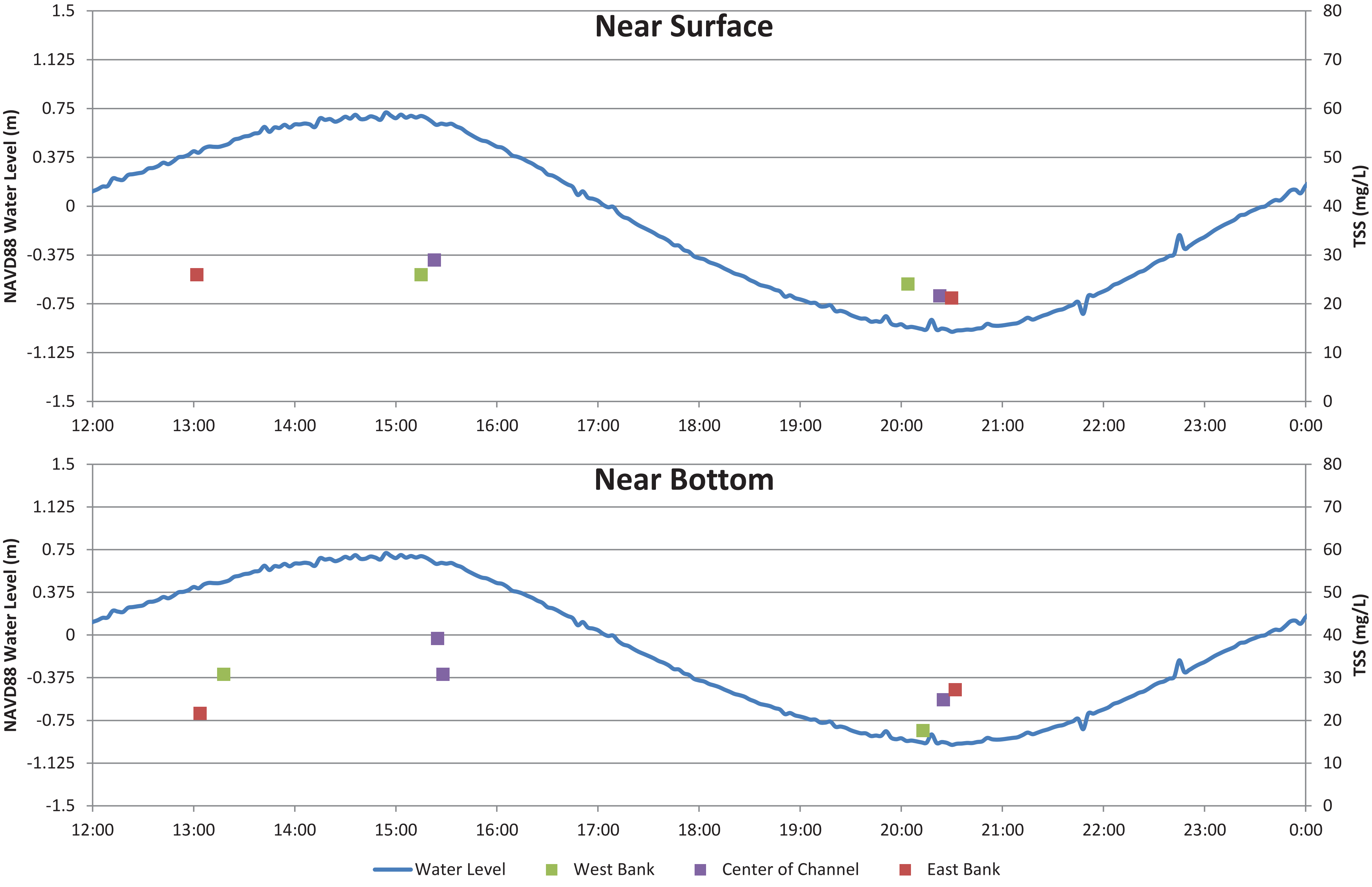
Snow's Cut (Transect 9) Water Samples - March 30, 2017



Southport (Transect 11) Water Samples - March 29, 2017



Southport (Transect 11) Water Samples - March 30, 2017



APPENDIX IX Vessel Mounted Current Survey Water Quality Profiles

File Name	**Date**	**Time**	**Line**	**Bank**
Wilmington_032817_121101	3/28/2017	12:11	6	Center
Wilmington_032817_125654	3/28/2017	12:56	6	Center
Wilmington_032817_134723	3/28/2017	13:47	6	Center
Wilmington_032917_140132	3/29/2017	14:01	6	Center
Wilmington_032917_144748	3/29/2017	14:47	6	Center
Wilmington_032917_160840	3/29/2017	16:08	6	Right
Wilmington_032917_162027	3/29/2017	16:20	6	Center
Wilmington_032917_162941	3/29/2017	16:29	6	Left
Wilmington_032917_171838	3/29/2017	17:18	6	Center
Wilmington_032917_183836	3/29/2017	18:38	6	Right
Wilmington_032917_185115	3/29/2017	18:51	6	Center
Wilmington_032917_200000	3/29/2017	20:00	6	Center
Wilmington_032917_204317	3/29/2017	20:43	6	Center
Wilmington_032917_214510	3/29/2017	21:45	6	Center
Wilmington_032917_223005	3/29/2017	22:30	6	Right
Wilmington_032917_224013	3/29/2017	22:40	6	Center
Wilmington_032917_224833	3/29/2017	22:48	6	Left
Wilmington_033017_121636	3/30/2017	12:16	6	Center
Wilmington_033017_125939	3/30/2017	12:59	6	Center
Wilmington_033017_134019	3/30/2017	13:40	6	Right
Wilmington_033017_134941	3/30/2017	13:49	6	Center
Wilmington_033017_140718	3/30/2017	14:07	6	Left
Wilmington_033017_152611	3/30/2017	15:26	6	Center
Wilmington_033017_160903	3/30/2017	16:09	6	Center
Wilmington_033017_164941	3/30/2017	16:49	6	Center
Wilmington_033017_180222	3/30/2017	18:02	6	Center
Wilmington_033017_184447	3/30/2017	18:44	6	Center
Wilmington_033017_192547	3/30/2017	19:25	6	Center
Wilmington_033017_200838	3/30/2017	20:08	6	Right
Wilmington_033017_201858	3/30/2017	20:18	6	Center
Wilmington_033017_203214	3/30/2017	20:32	6	Left
Wilmington_033017_214545	3/30/2017	21:45	6	Center
Wilmington_033017_222617	3/30/2017	22:26	6	Center
Wilmington_033117_113337	3/31/2017	11:33	3	Center
Wilmington_033117_115256	3/31/2017	11:52	3	Center
Wilmington_033117_121134	3/31/2017	12:11	3	Center
Wilmington_033117_123003	3/31/2017	12:30	3	Center
Wilmington_033117_145847	3/31/2017	14:58	3	Center
Wilmington_033117_152427	3/31/2017	15:24	3	Center
Wilmington_033117_154735	3/31/2017	15:47	3	Center
Wilmington_033117_161201	3/31/2017	16:12	3	Center
Wilmington_033117_163307	3/31/2017	16:33	3	Center
Wilmington_033117_165811	3/31/2017	16:58	3	Center
Wilmington_033117_172504	3/31/2017	17:25	3	Center
Wilmington_033117_175419	3/31/2017	17:54	3	Center

File Name	**Date**	**Time**	**Line**	**Bank**
CapeFearProfile_032917_123846	3/29/2017	12:38	9	Center
CapeFearProfile_032917_144356	3/29/2017	14:43	9	Center
CapeFearProfile_032917_154922	3/29/2017	15:49	9	Center
CapeFearProfile_032917_172823	3/29/2017	17:28	9	Center
CapeFearProfile_032917_185059	3/29/2017	18:50	9	Center
CapeFearProfile_032917_185750	3/29/2017	18:57	9	Left
CapeFearProfile_032917_192835	3/29/2017	19:28	9	Right
CapeFearProfile_032917_204410	3/29/2017	20:44	9	Center
CapeFearProfile_032917_215625	3/29/2017	21:56	9	Center
CapeFearProfile_032917_225534	3/29/2017	22:55	9	Center
CapeFearProfile_033017_121940	3/30/2017	12:19	9	Center
CapeFearProfile_033017_132137	3/30/2017	13:21	9	Left
CapeFearProfile_033017_135328	3/30/2017	13:53	9	Center
CapeFearProfile_033017_135850	3/30/2017	13:58	9	Right
CapeFearProfile_033017_152551	3/30/2017	15:25	9	Center
CapeFearProfile_033017_162349	3/30/2017	16:23	9	Center
CapeFearProfile_033017_173100	3/30/2017	17:31	9	Center
CapeFearProfile_033017_184013	3/30/2017	18:40	9	Center
CapeFearProfile_033017_194623	3/30/2017	19:46	9	Left
CapeFearProfile_033017_200216	3/30/2017	20:02	9	Center
CapeFearProfile_033017_203158	3/30/2017	20:31	9	Right
CapeFearProfile_033017_213839	3/30/2017	21:38	9	Center
CapeFearProfile_033017_224310	3/30/2017	22:43	9	Center
CapeFearProfile_033117_112841	3/31/2017	11:28	9	Center
CapeFearProfile_033117_124425	3/31/2017	12:44	9	Center
CapeFearProfile_033117_151107	3/31/2017	15:11	9	Center
CapeFearProfile_033117_162617	3/31/2017	16:26	9	Center
CapeFearProfile_033117_172313	3/31/2017	17:23	9	Center
Southport_032917_120329	3/29/2017	12:03	11	Center
Southport_032917_134048	3/29/2017	13:40	11	Right
Southport_032917_135232	3/29/2017	13:52	11	Center
Southport_032917_140211	3/29/2017	14:02	11	Left
Southport_032917_151842	3/29/2017	15:18	11	Center
Southport_032917_163654	3/29/2017	16:36	11	Center
Southport_032917_180615	3/29/2017	18:06	11	Center
Southport_032917_195213	3/29/2017	19:52	11	Left
Southport_032917_200447	3/29/2017	20:04	11	Center
Southport_032917_201650	3/29/2017	20:16	11	Right
Southport_032917_213351	3/29/2017	21:33	11	Left
Southport_032917_214423	3/29/2017	21:44	11	Center
Southport_032917_215309	3/29/2017	21:53	11	Right
Southport_032917_231412	3/29/2017	23:14	11	Center
Southport_033017_114310	3/30/2017	11:43	11	Center
Southport_033017_130756	3/30/2017	13:07	11	Left
Southport_033017_132018	3/30/2017	13:20	11	Right

File Name	Date	Time	Line	Bank
Southport_033017_133425	3/30/2017	13:34	11	Center
Southport_033017_144359	3/30/2017	14:43	11	Center
Southport_033017_162443	3/30/2017	16:24	11	Center
Southport_033017_173756	3/30/2017	17:37	11	Center
Southport_033017_185535	3/30/2017	18:55	11	Center
Southport_033017_201739	3/30/2017	20:17	11	Right
Southport_033017_202742	3/30/2017	20:27	11	Center
Southport_033017_212847	3/30/2017	21:28	11	Center
Southport_033017_221312	3/30/2017	22:13	11	Center
Southport_033117_111638	3/31/2017	11:16	11	Center
Southport_033117_120941	3/31/2017	12:09	11	Center

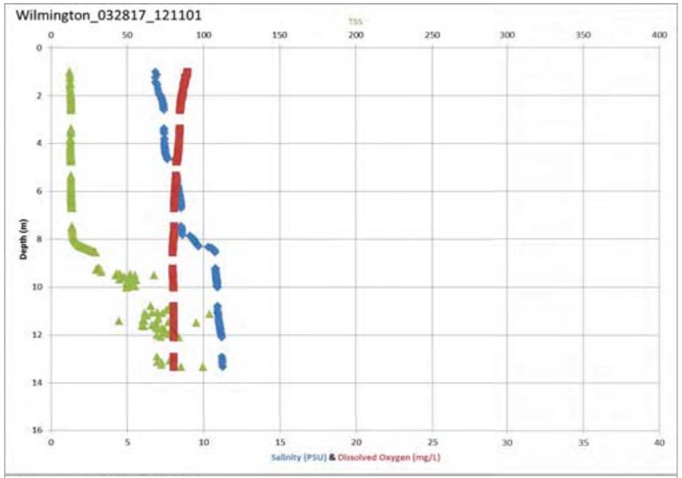
Personnel: Jesse
Location: Wilmington

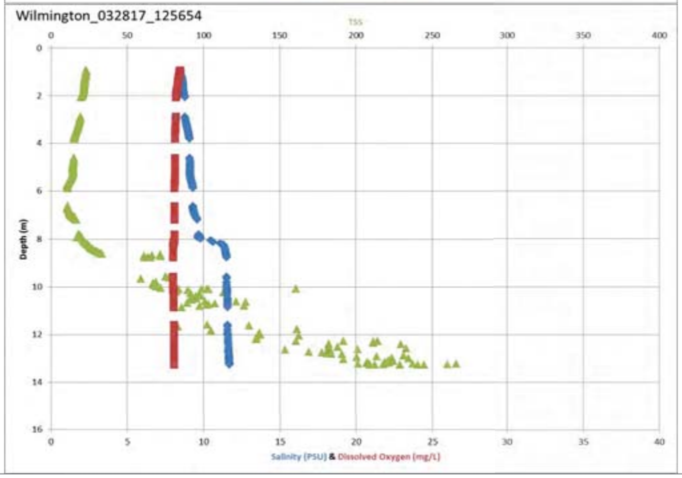
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

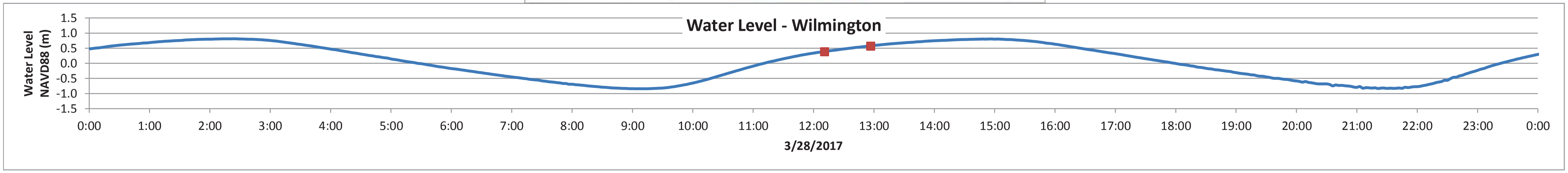
Left Bank

Center of Channel





Right Bank



Personnel: Jesse
Location: Wilmington

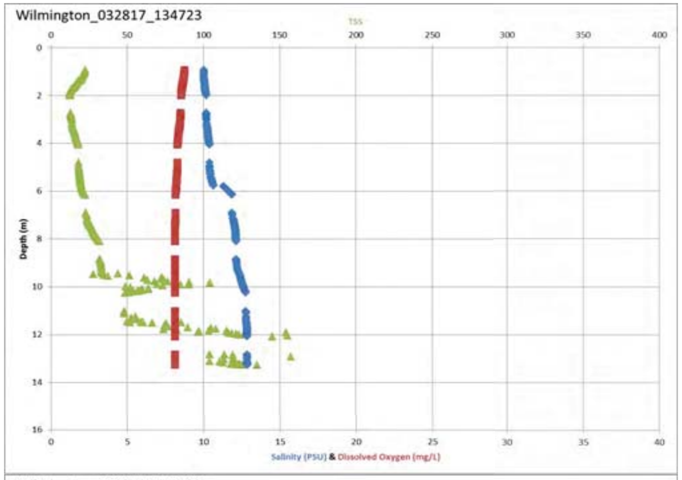
Cape Fear CTD Cast Data

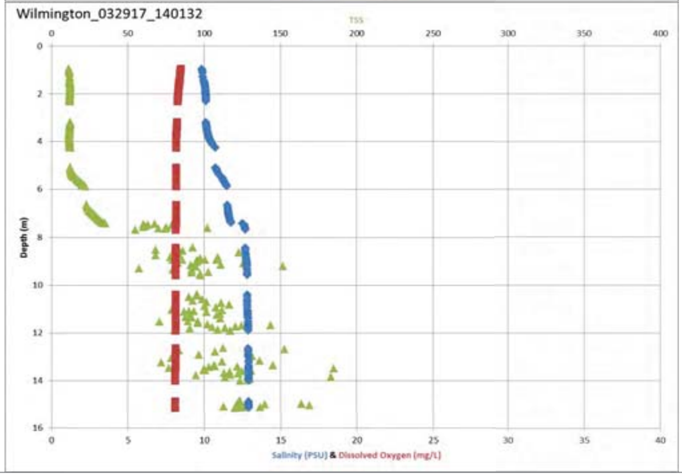
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

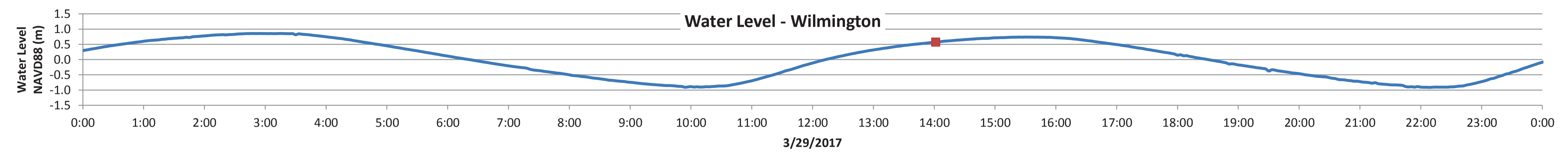
Left Bank

Center of Channel

Right Bank







Personnel: Jesse
Location: Wilmington

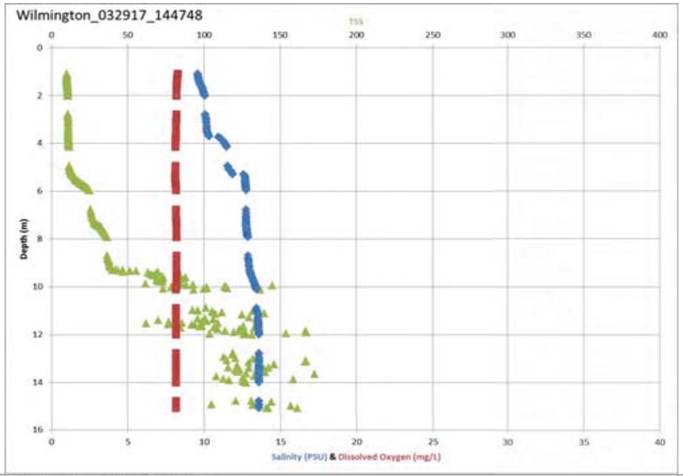
Cape Fear CTD Cast Data

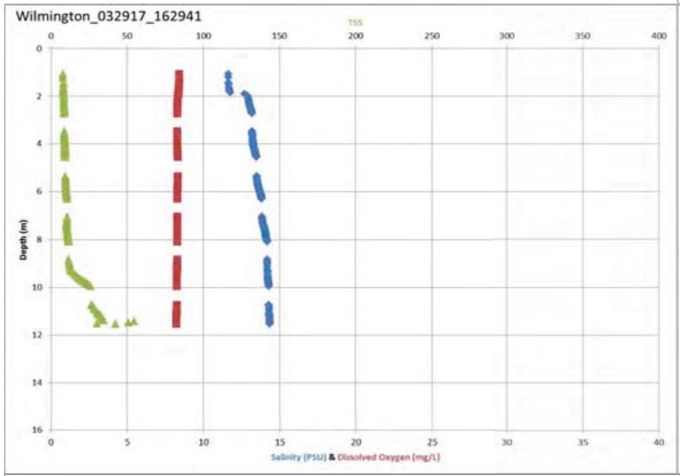
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

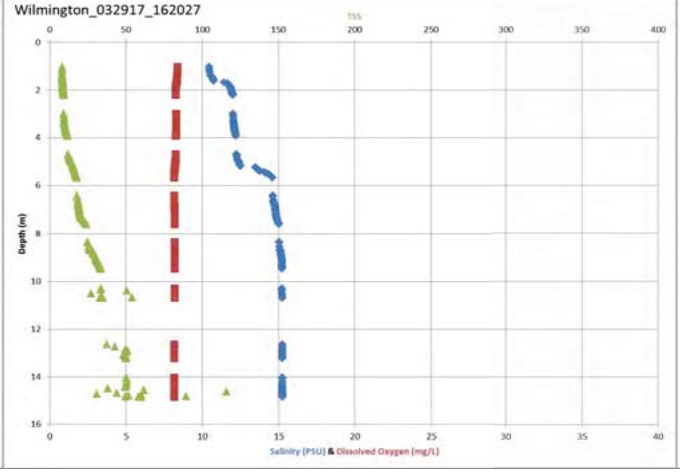
Left Bank

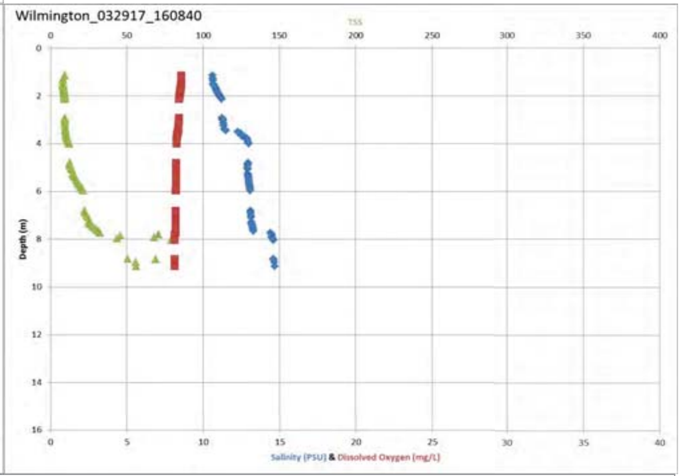
Center of Channel

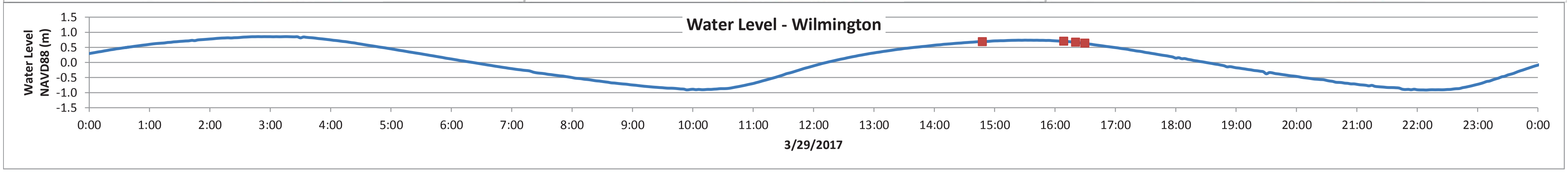
Right Bank











Personnel: Jesse
Location: Wilmington

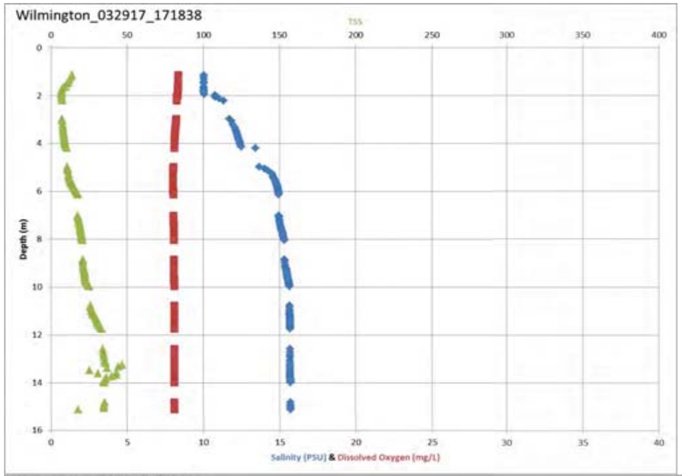
Cape Fear CTD Cast Data

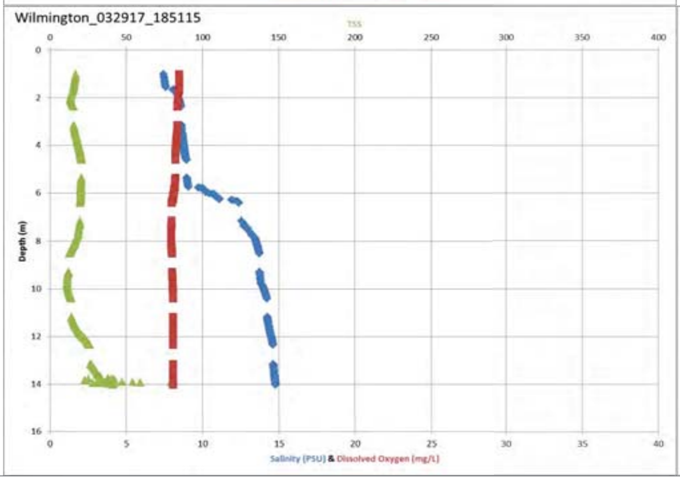
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

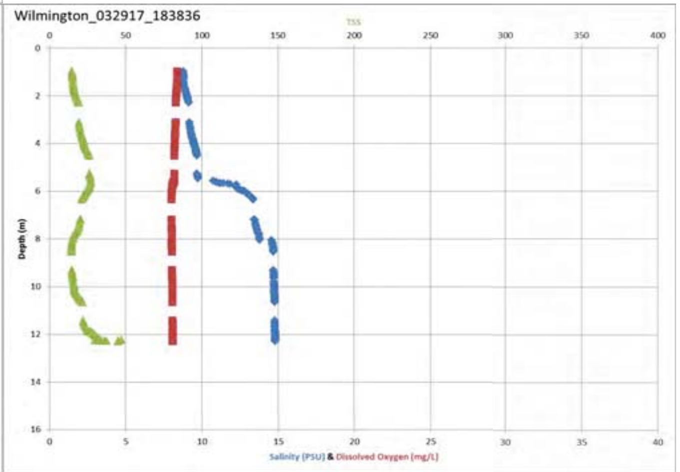
Left Bank

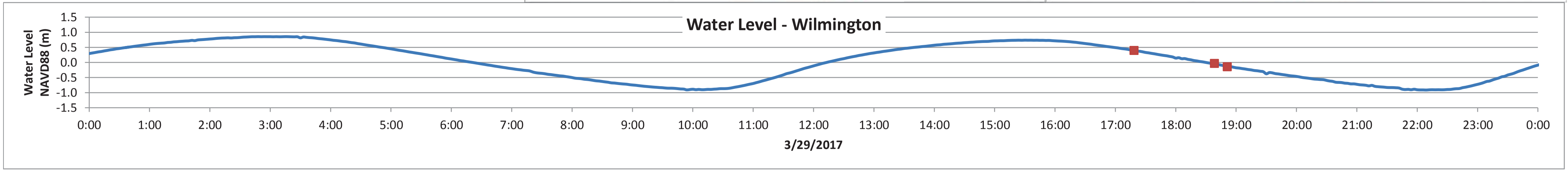
Center of Channel

Right Bank









Personnel: Jesse
Location: Wilmington

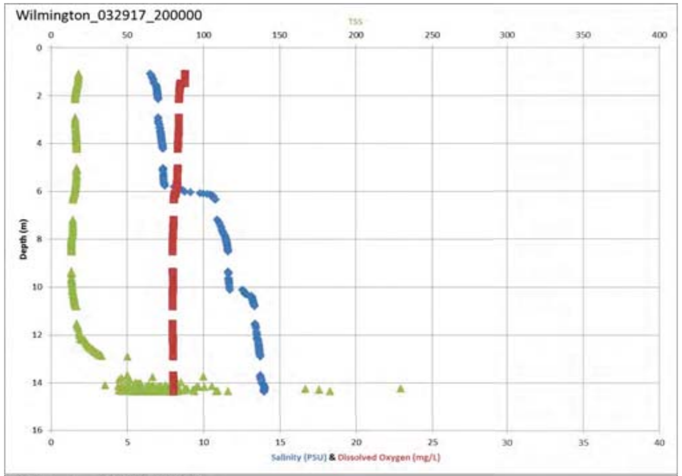
Cape Fear CTD Cast Data

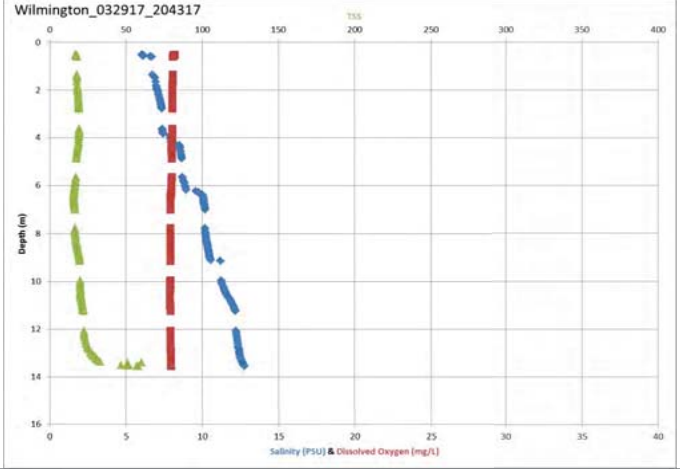
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

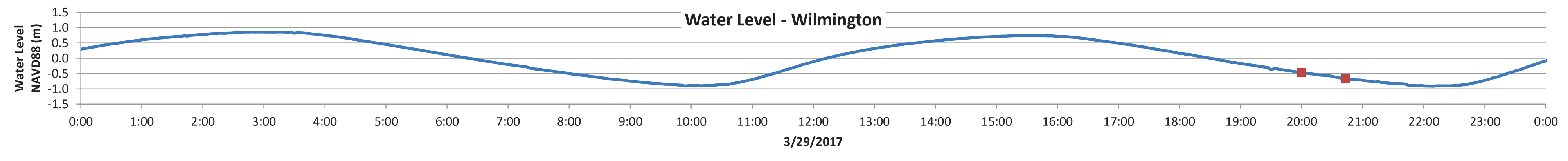
Left Bank

Center of Channel

Right Bank







Personnel: Jesse
Location: Wilmington

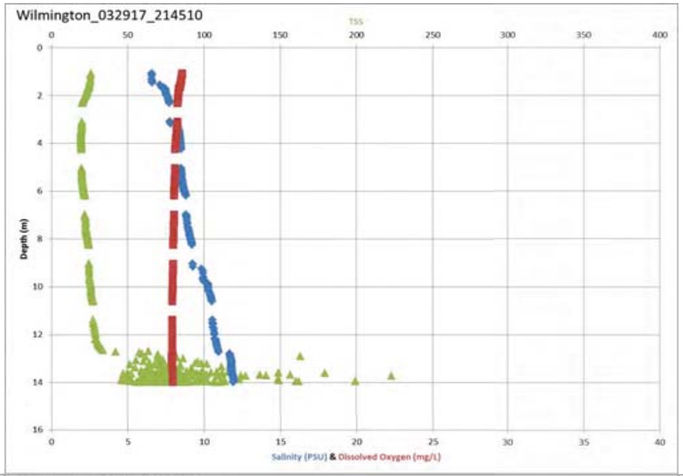
Cape Fear CTD Cast Data

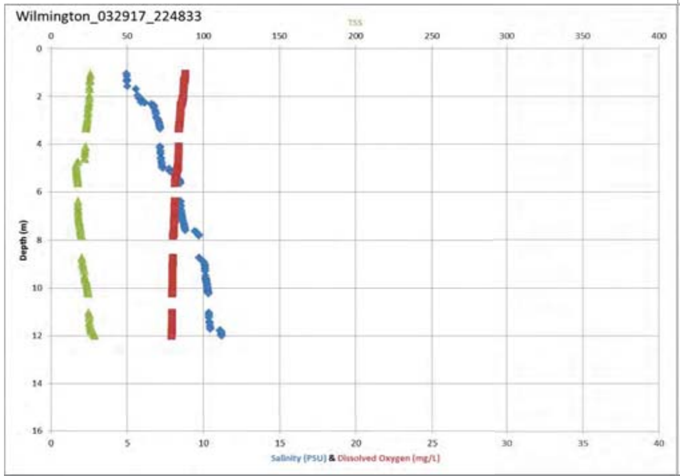
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

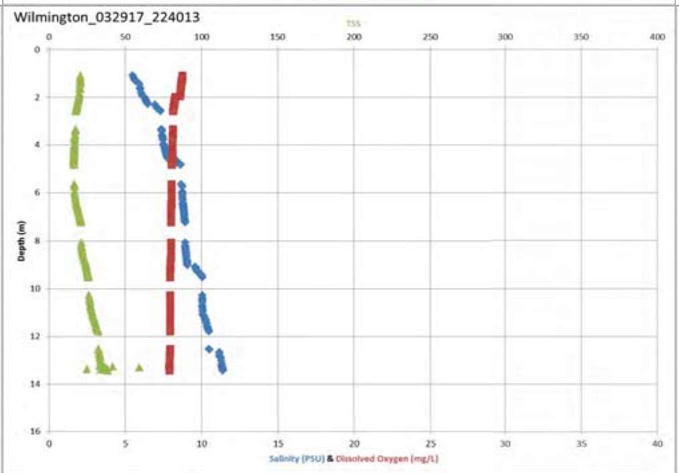
Left Bank

Center of Channel

Right Bank


Wilmington_032917_214510


Wilmington_032917_224833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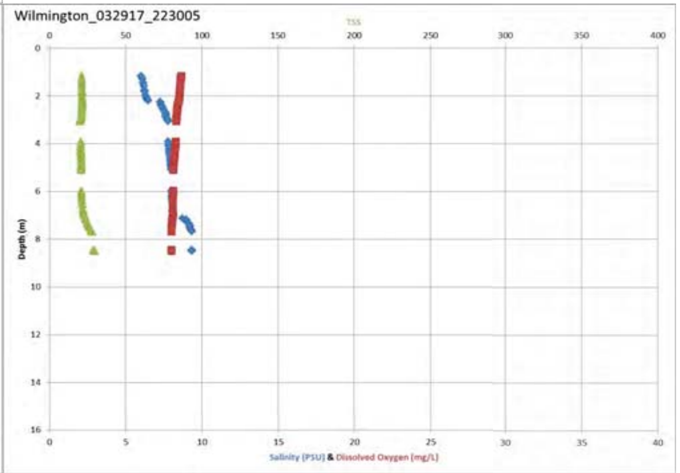
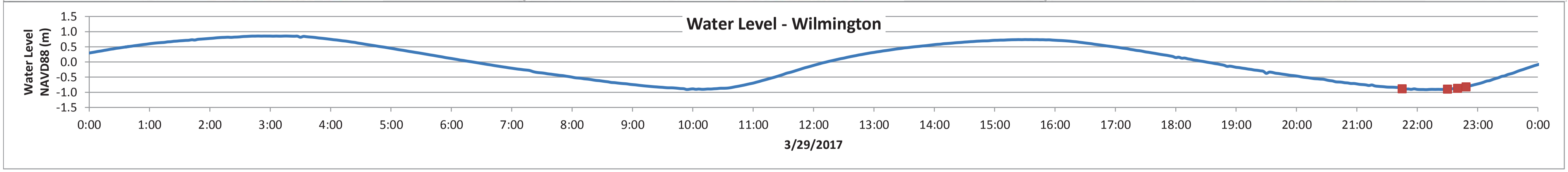

Wilmington_032917_223005


Water Level - Wilmington

Personnel: Jesse
Location: Wilmington

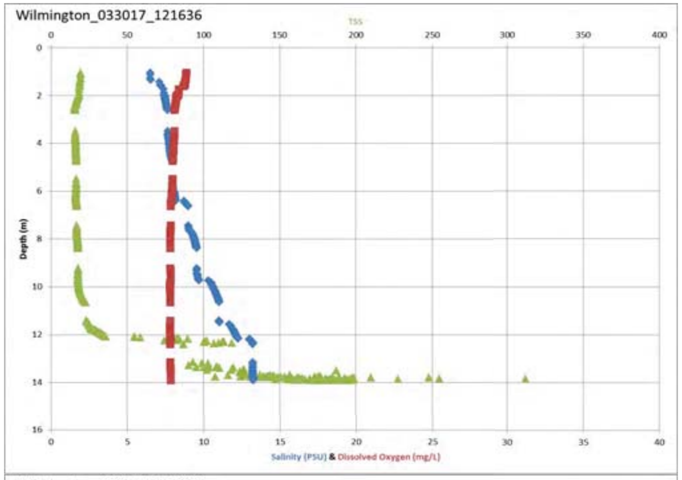
Cape Fear CTD Cast Data

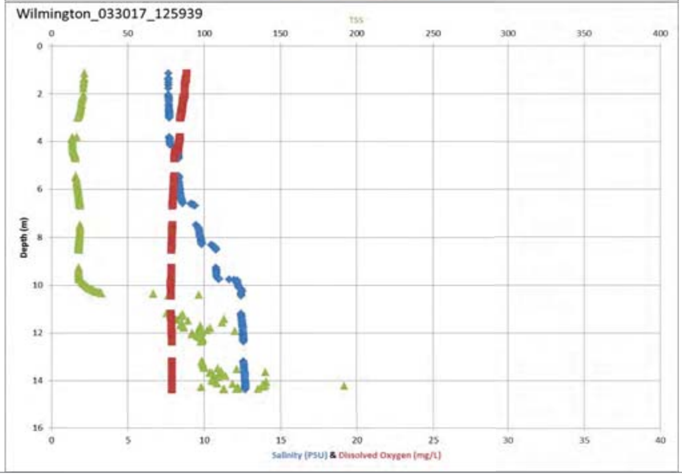
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

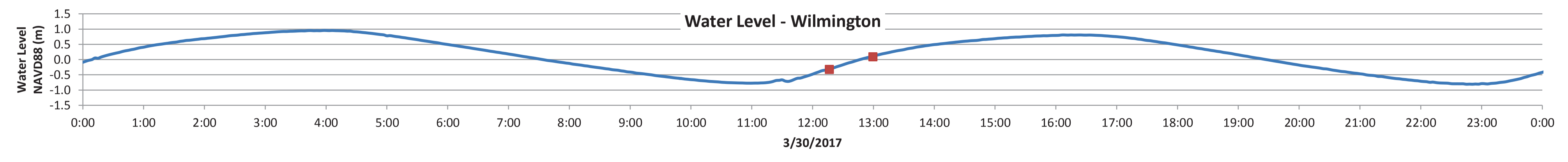
Left Bank

Center of Channel

Right Bank





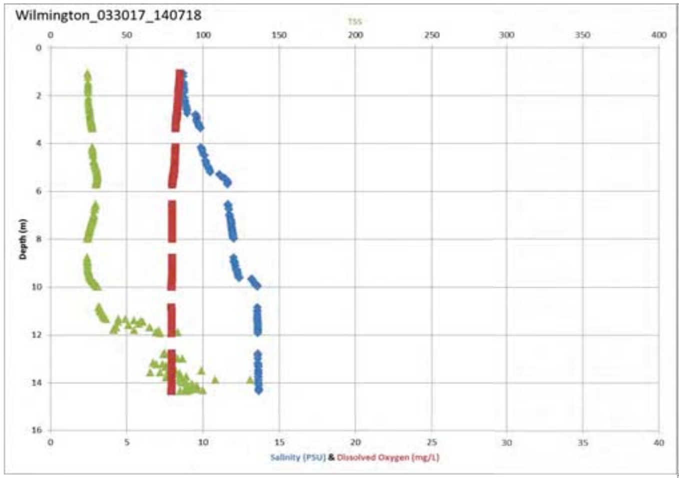


Personnel: Jesse
Location: Wilmington

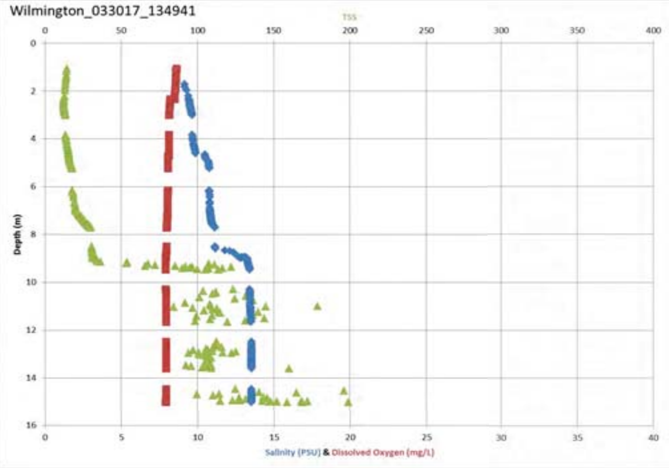
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

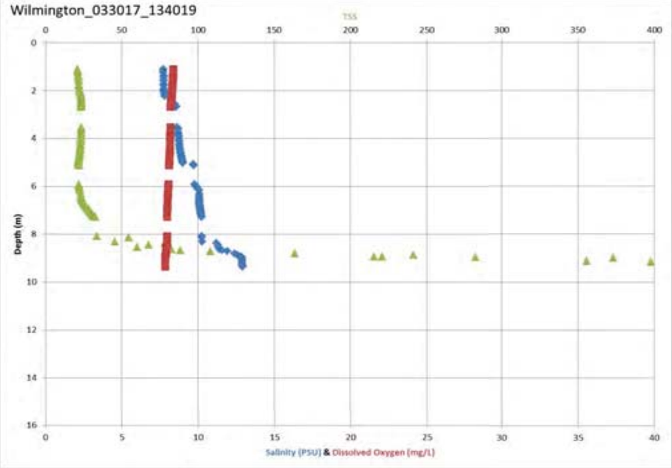
Left Bank

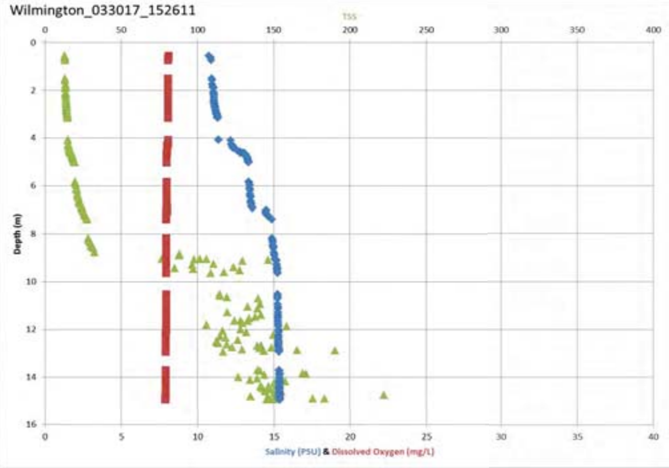


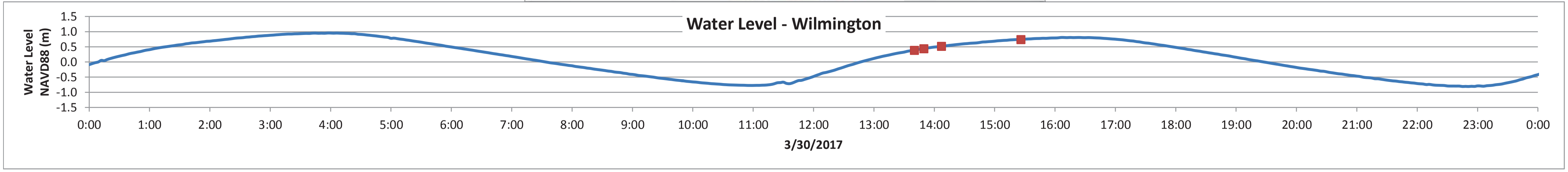
Center of Channel



Right Bank







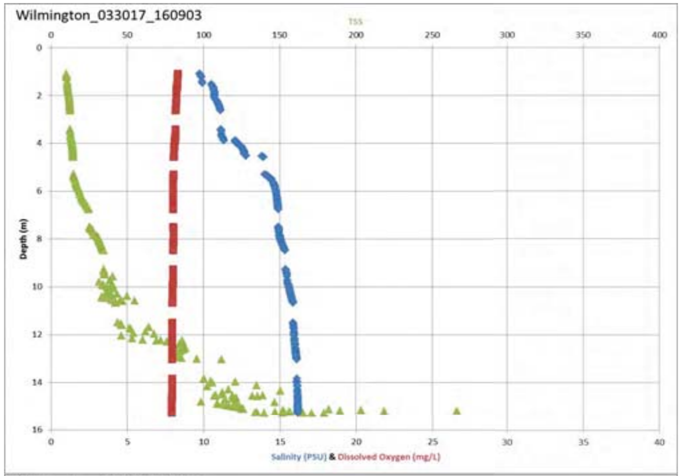
Personnel: Jesse
Location: Wilmington

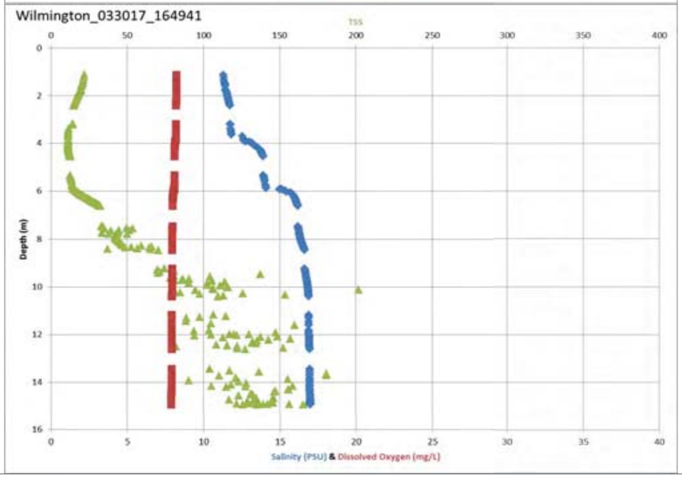
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

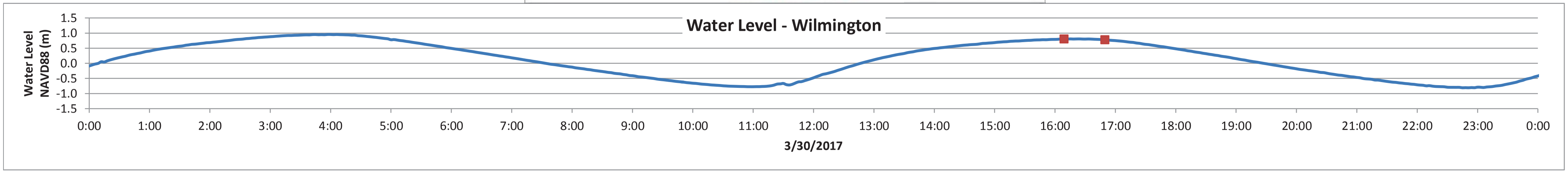
Left Bank

Center of Channel





Right Bank



Personnel: Jesse
Location: Wilmington

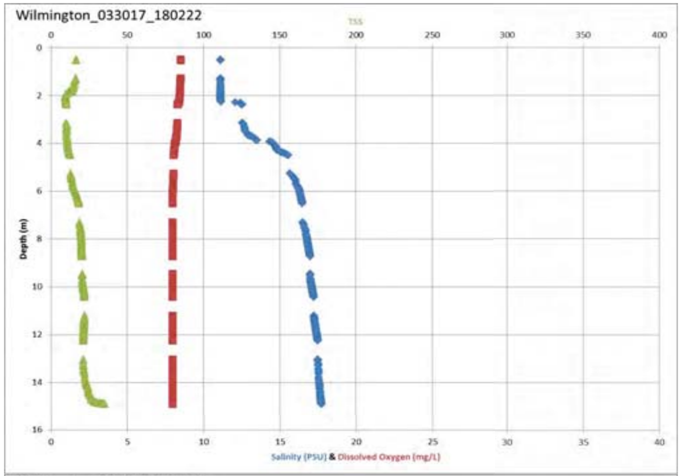
Cape Fear CTD Cast Data

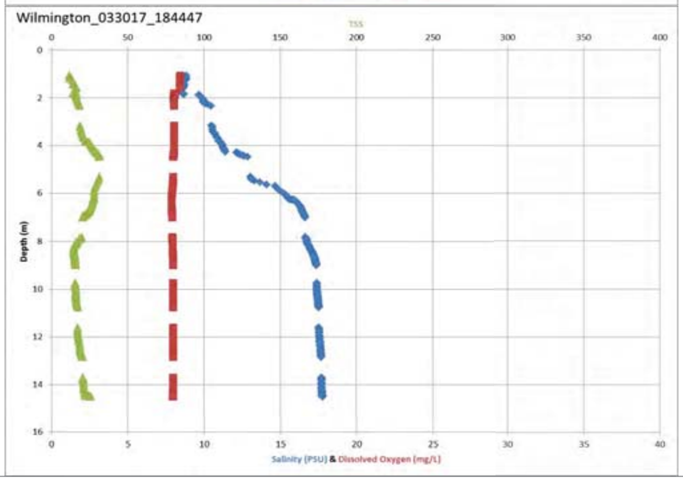
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

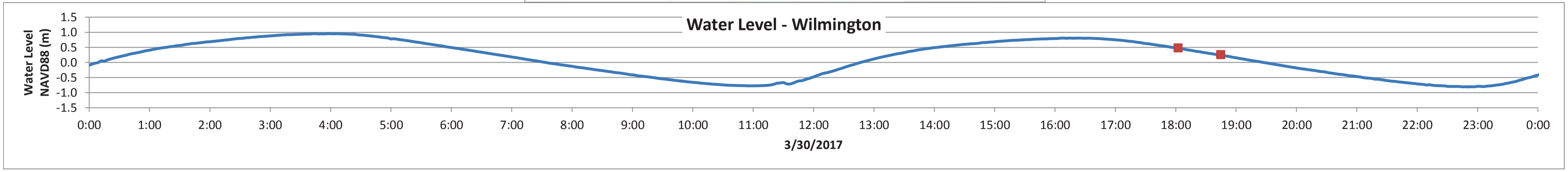
Left Bank

Center of Channel

Right Bank





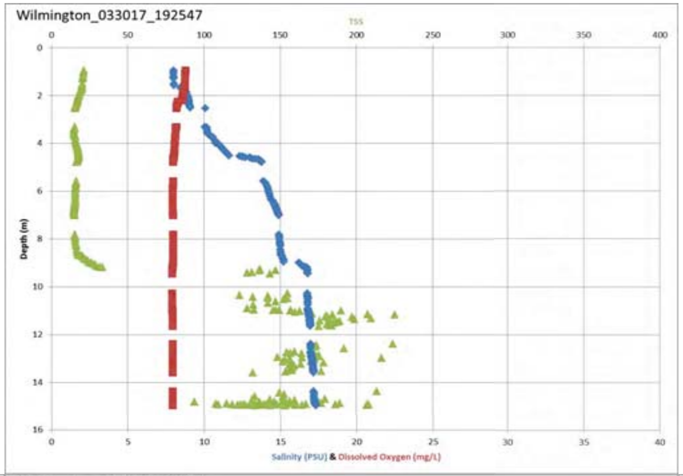


Personnel: Jesse
Location: Wilmington

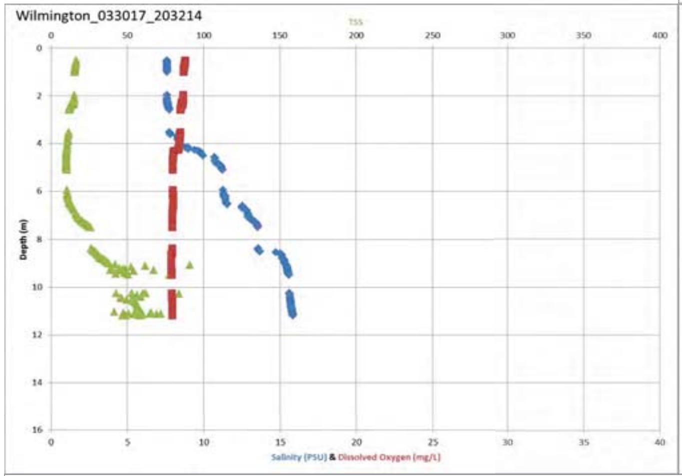
Cape Fear CTD Cast Data

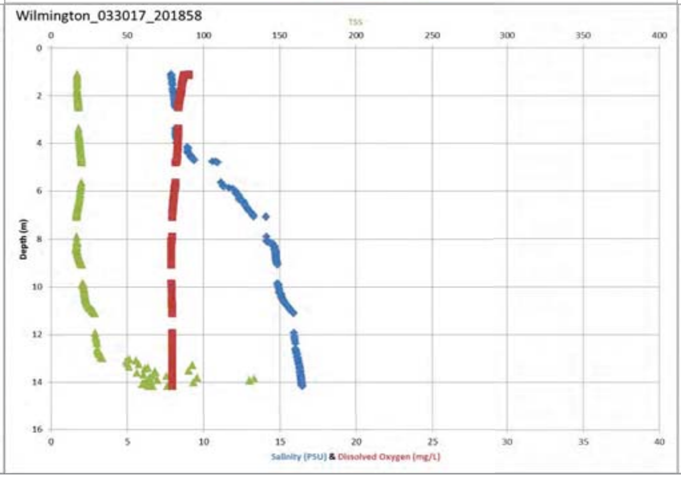
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

Center of Channel

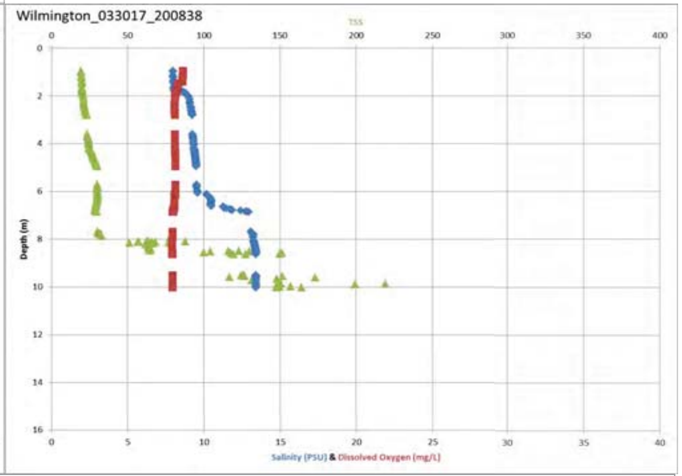


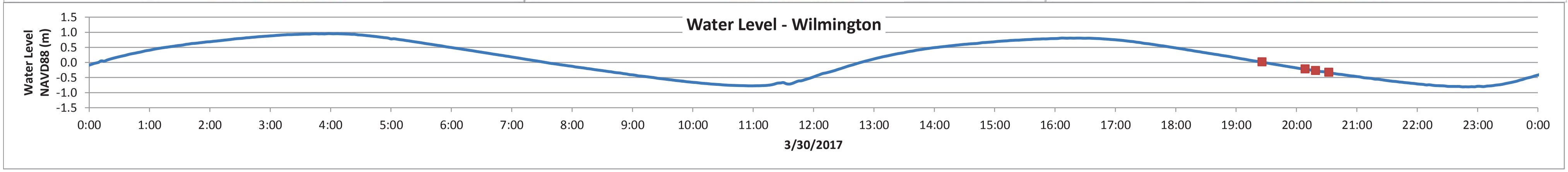
Left Bank





Right Bank





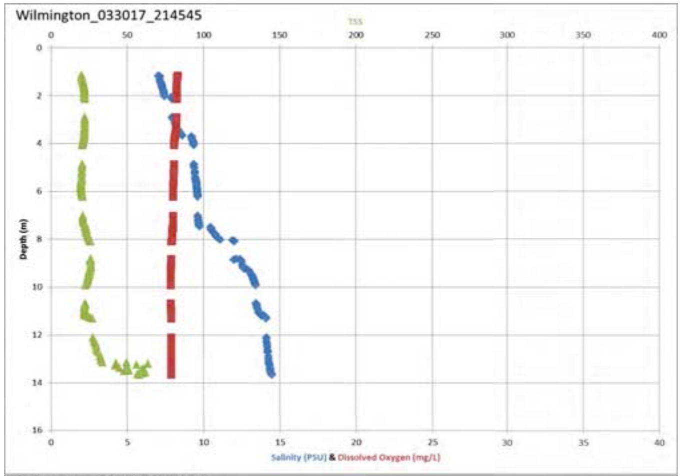
Personnel: Jesse
Location: Wilmington

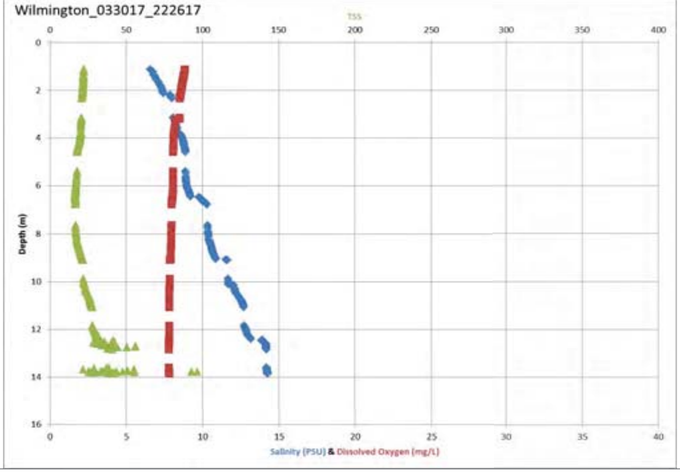
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

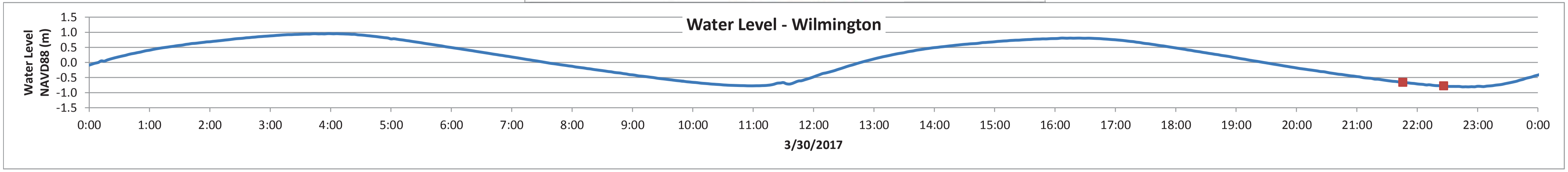
Left Bank

Center of Channel





Right Bank



Personnel: Jesse
Location: Wilmington

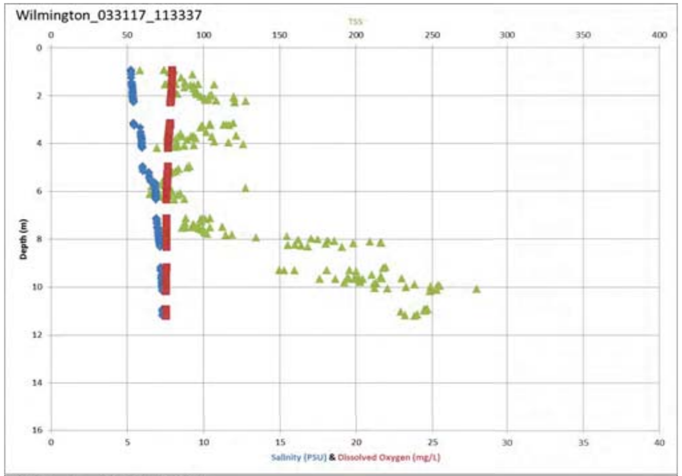
Cape Fear CTD Cast Data

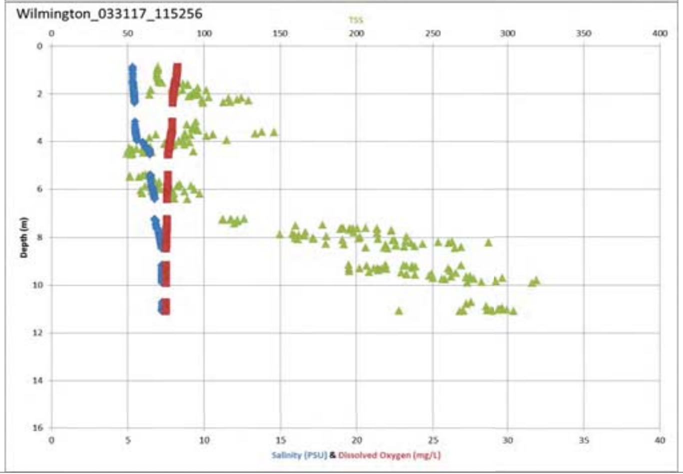
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

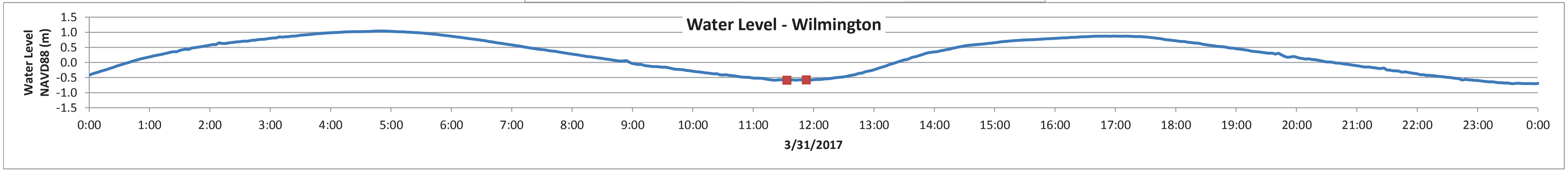
Left Bank

Center of Channel

Right Bank







Personnel: Jesse
Location: Wilmington

Cape Fear CTD Cast Data

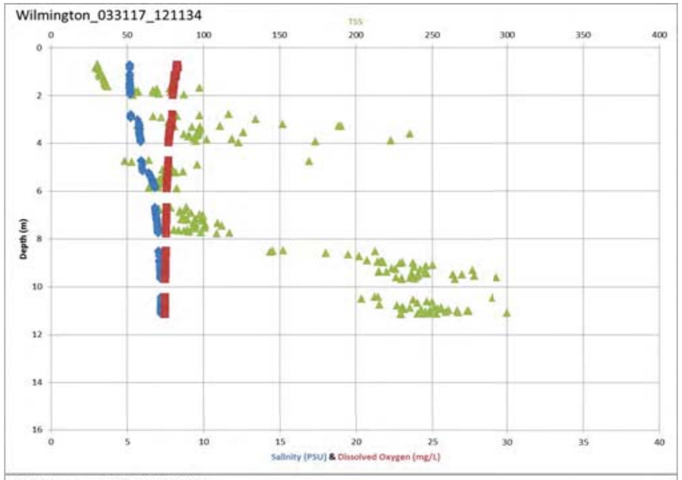
Down Casts only

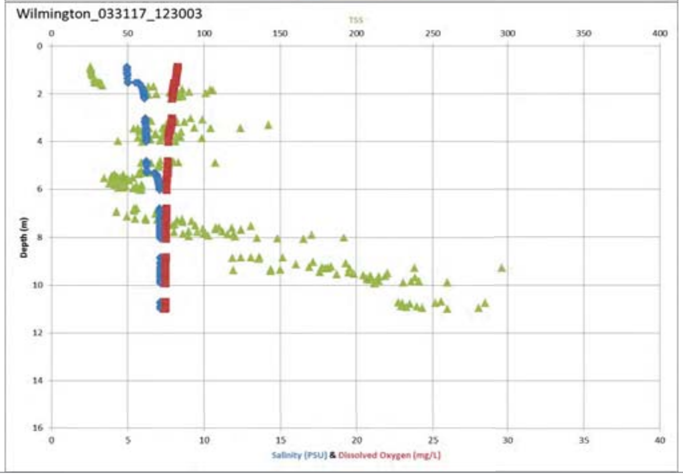
▲ TSS ◆ Salinity ■ Dissolved Oxygen

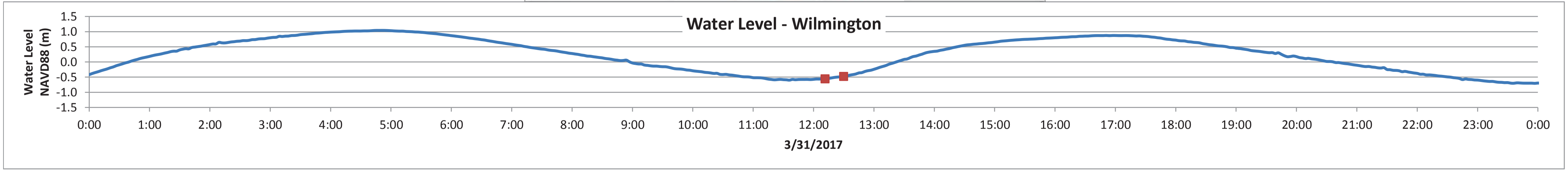
Left Bank

Center of Channel

Right Bank







Personnel: Jesse
Location: Wilmington

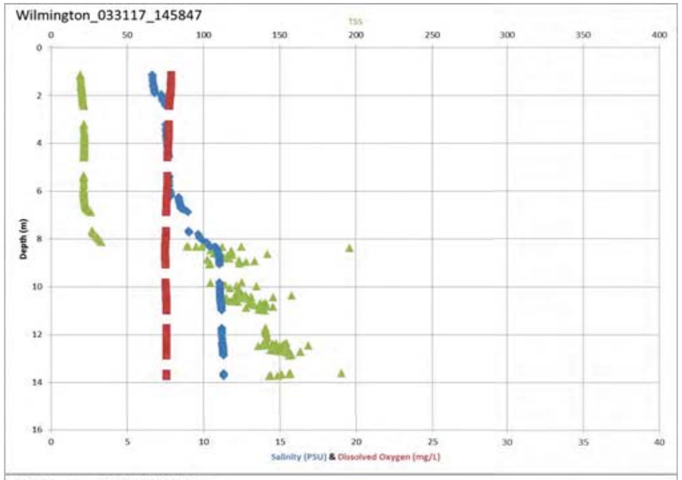
Cape Fear CTD Cast Data

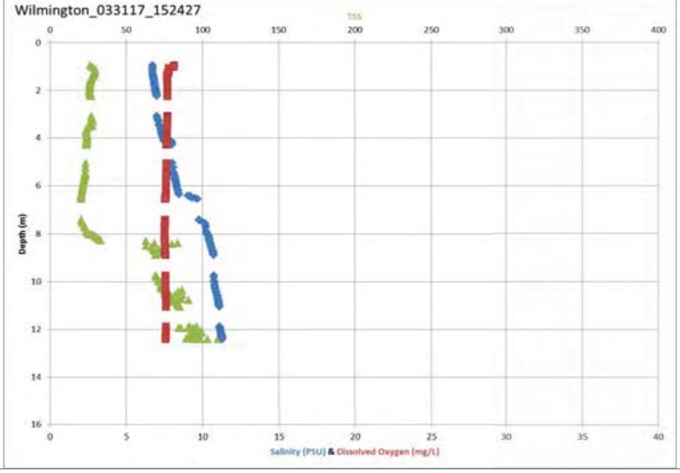
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

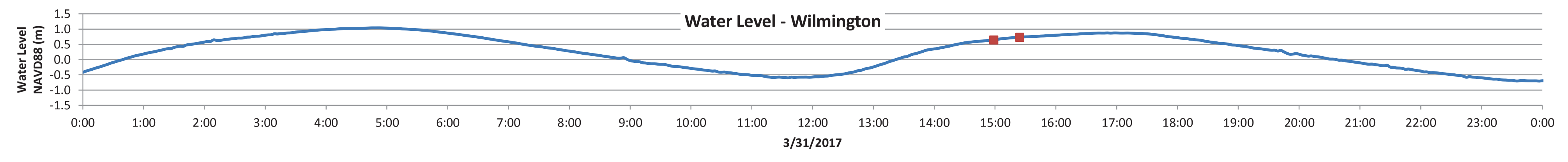
Left Bank

Center of Channel

Right Bank







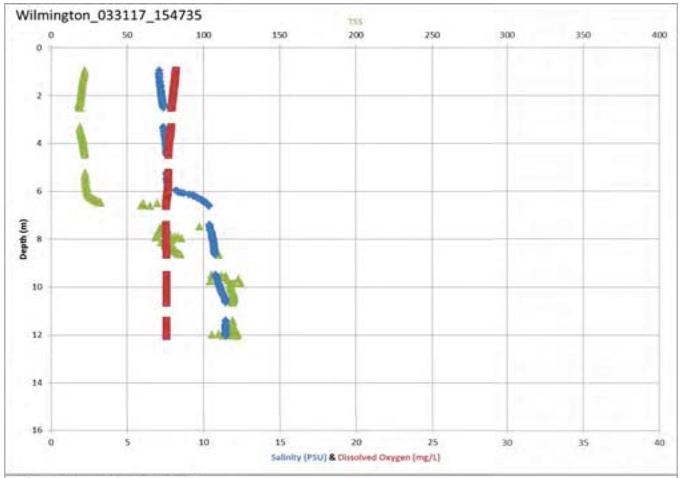
Personnel: Jesse
Location: Wilmington

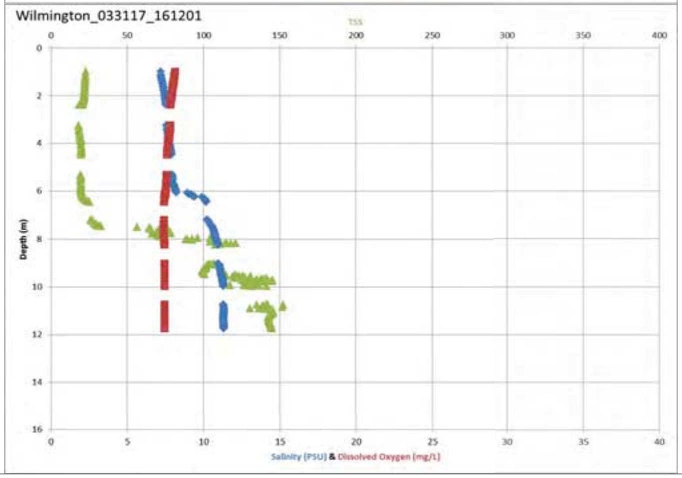
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

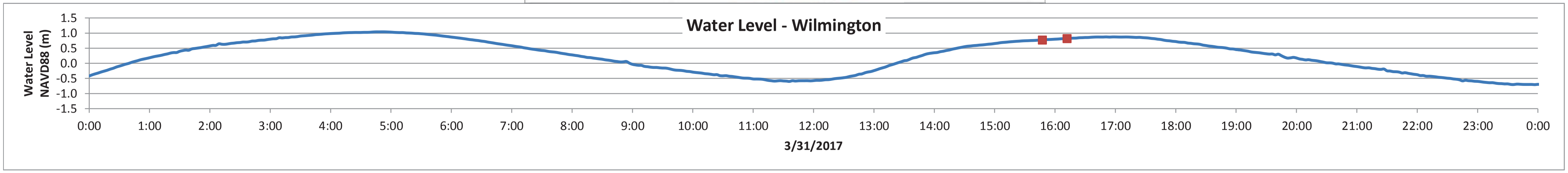
Left Bank

Center of Channel





Right Bank



Personnel: Jesse
Location: Wilmington

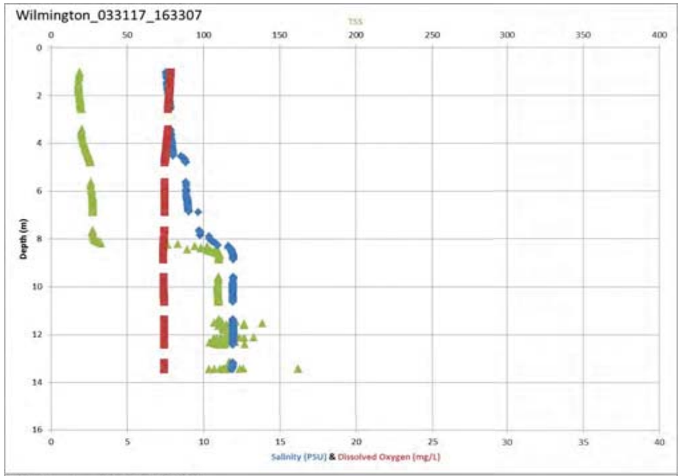
Cape Fear CTD Cast Data

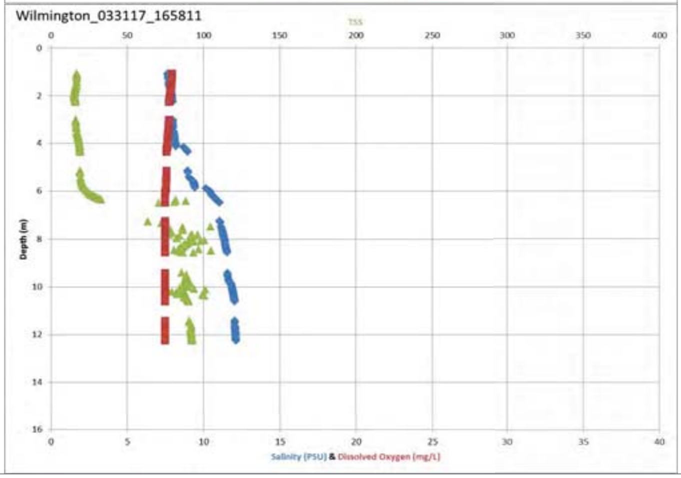
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

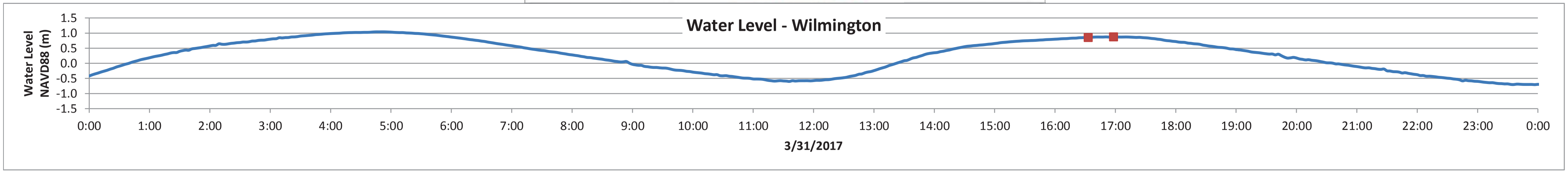
Left Bank

Center of Channel

Right Bank







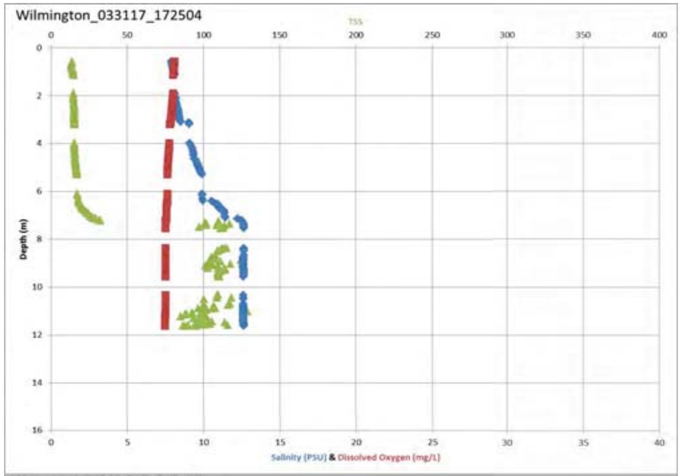
Personnel: Jesse
Location: Wilmington

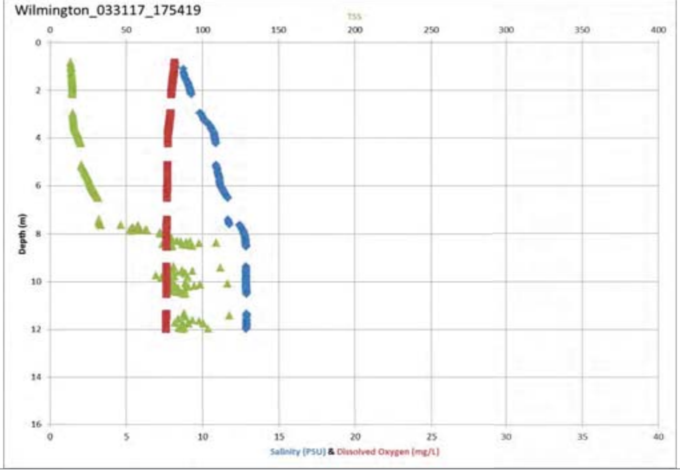
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

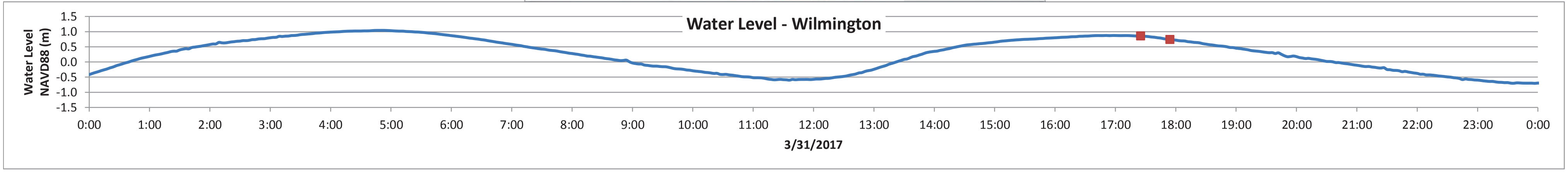
Left Bank

Center of Channel





Right Bank



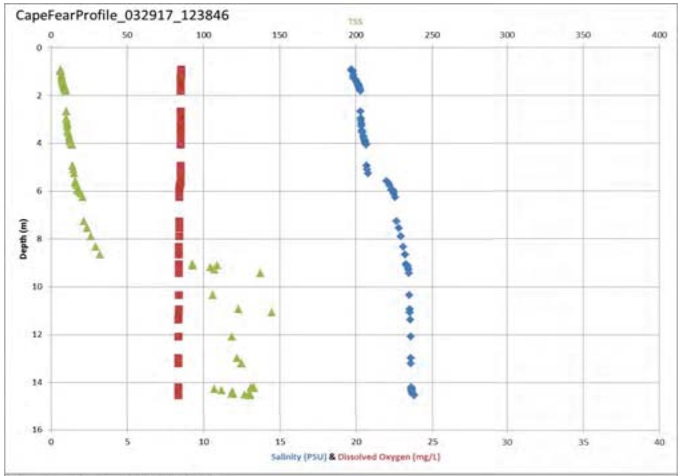
Personnel: Nate
Location: Snow's Cut

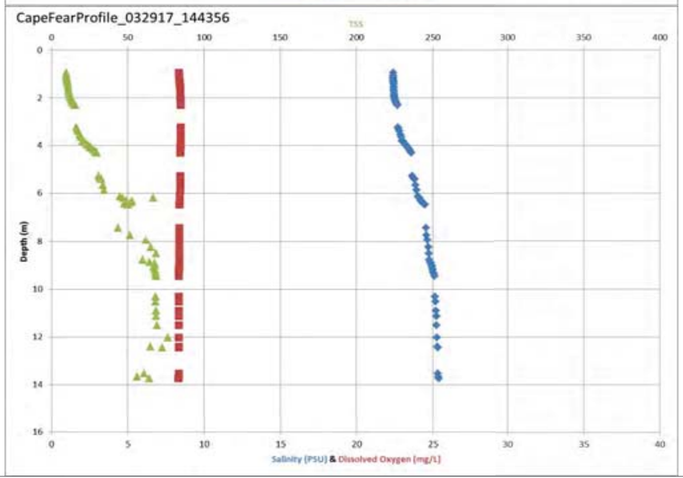
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

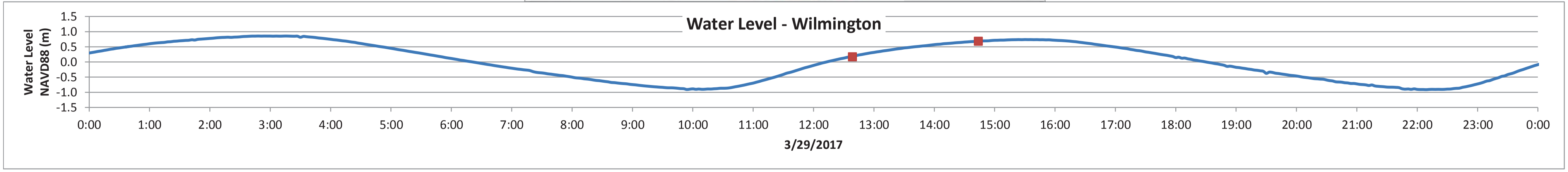
Left Bank

Center of Channel





Right Bank



Personnel: Nate
Location: Snow's Cut

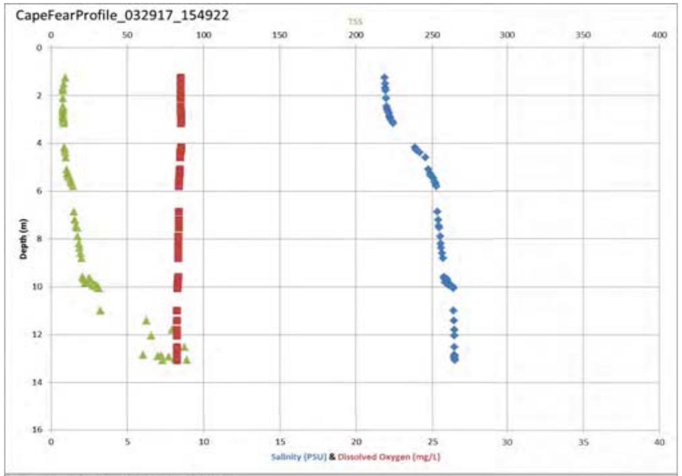
Cape Fear CTD Cast Data

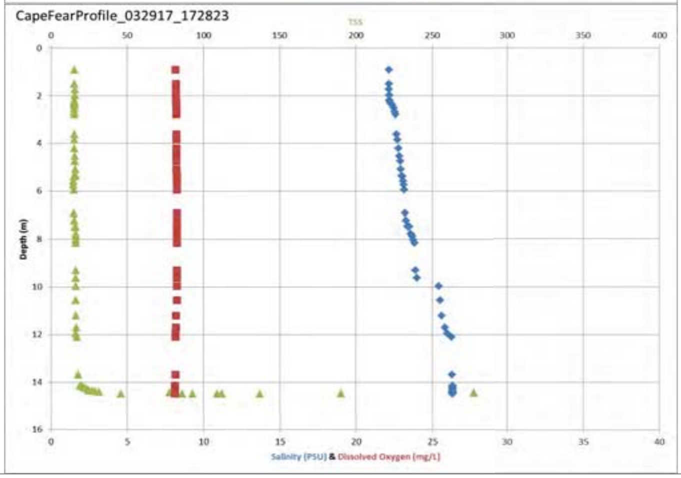
Down Casts only
🟩 TSS ◆ Salinity 🟥 Dissolved Oxygen

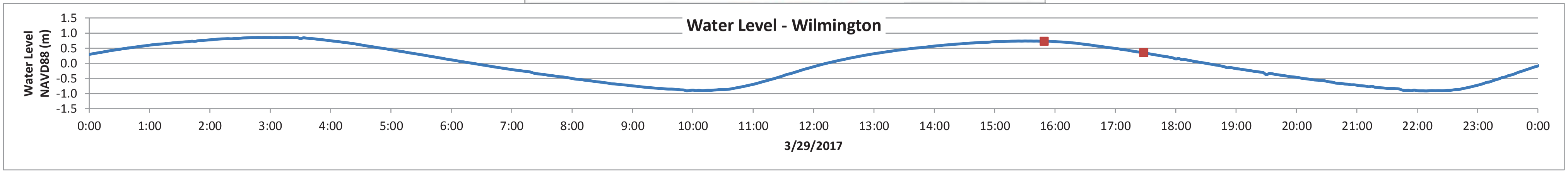
Left Bank

Center of Channel

Right Bank





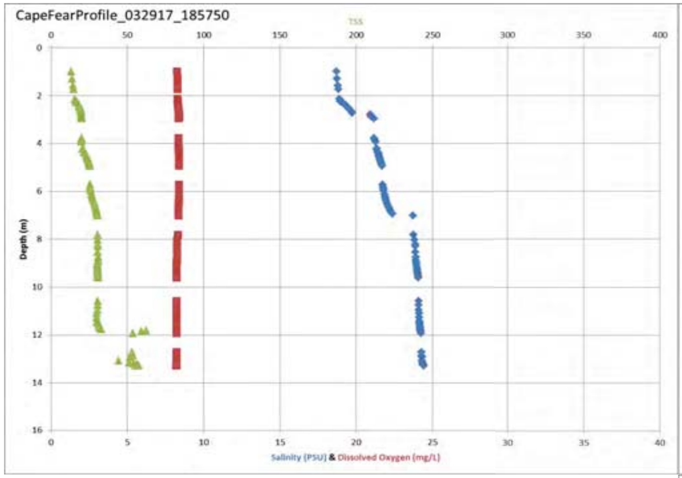


Personnel: Nate
Location: Snow's Cut

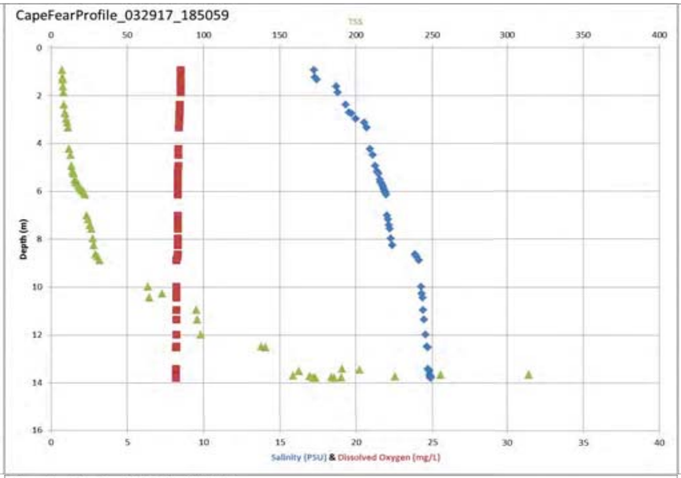
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

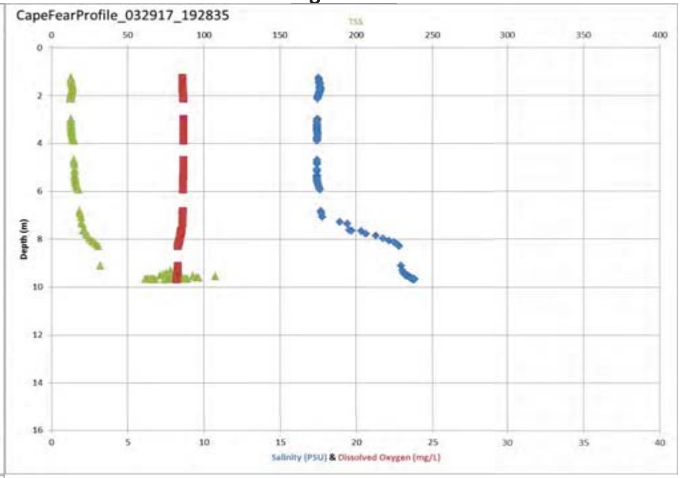
Left Bank

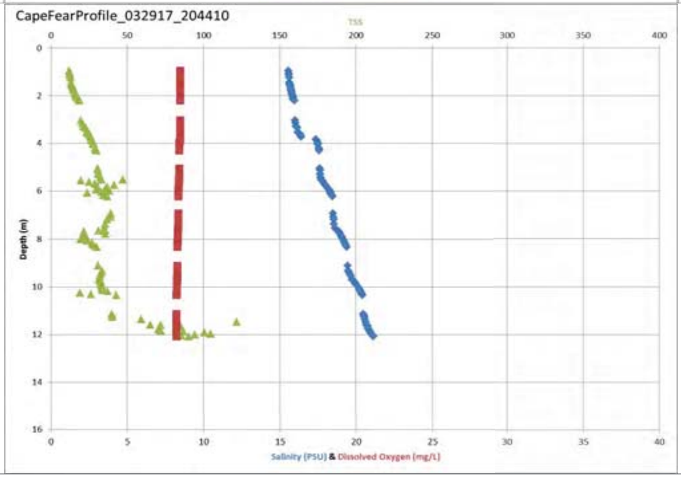


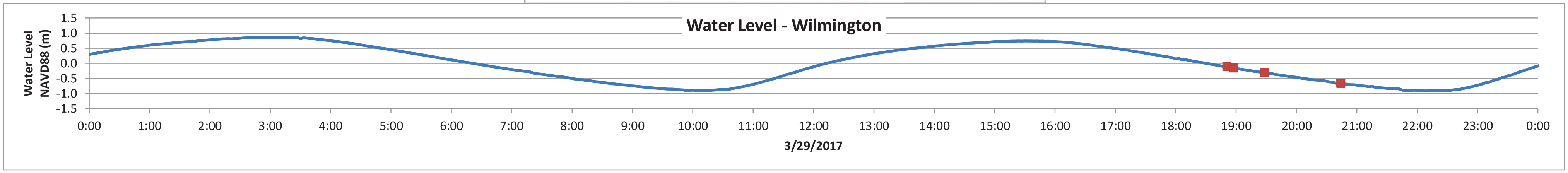
Center of Channel



Right Bank







Personnel: Nate
Location: Snow's Cut

Cape Fear CTD Cast Data

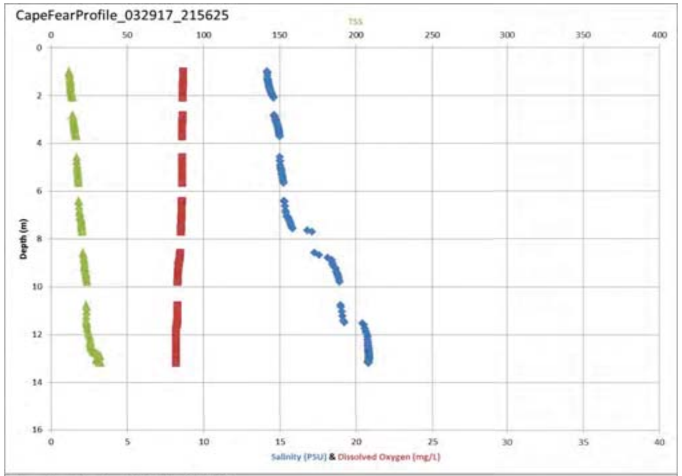
Down Casts only
🟩 TSS ◆ Salinity 🟥 Dissolved Oxygen

Left Bank

Center of Channel

Right Bank

CapeFearProfile_032917_215625



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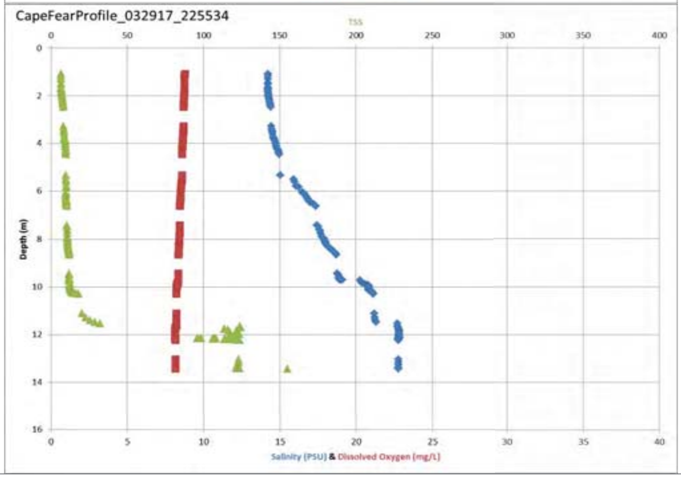
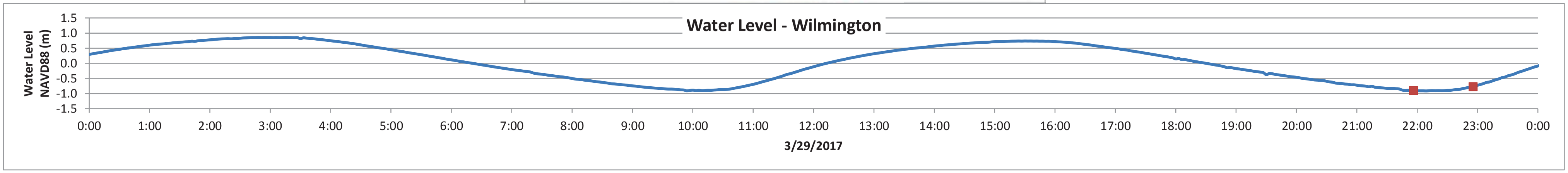




Personnel: Nate
Location: Snow's Cut

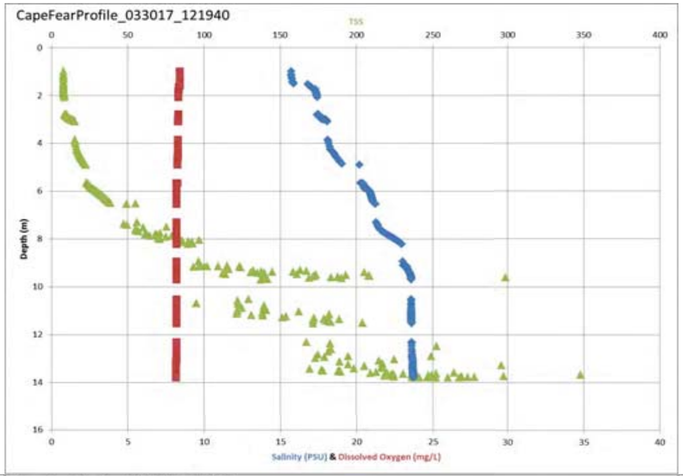
Cape Fear CTD Cast Data

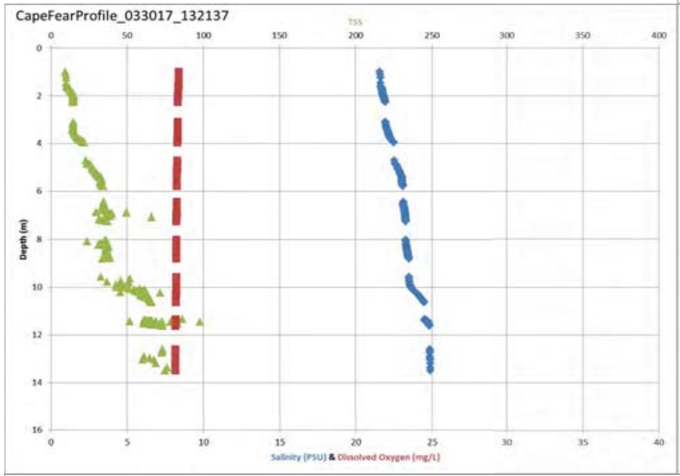
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

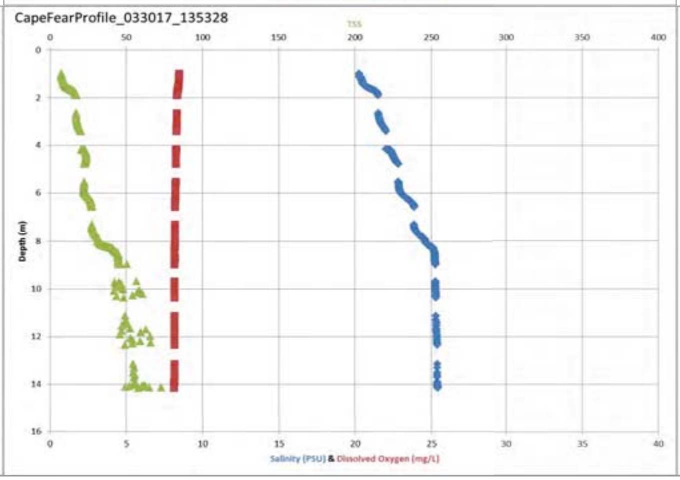
Left Bank

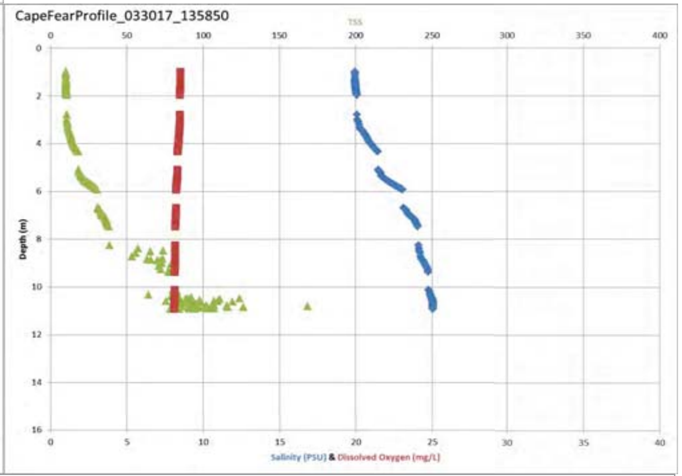
Center of Channel

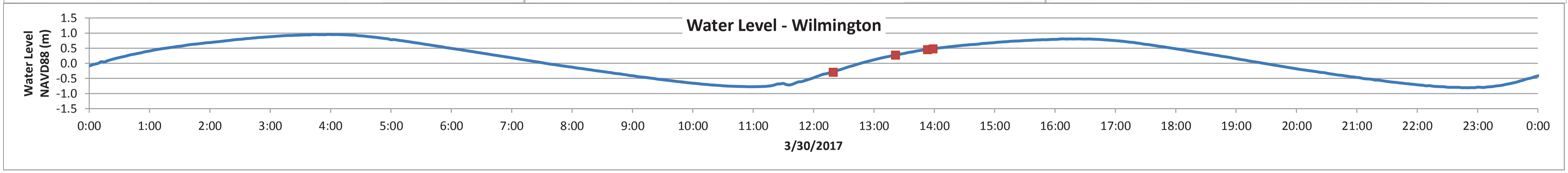
Right Bank











Personnel: Nate
Location: Snow's Cut

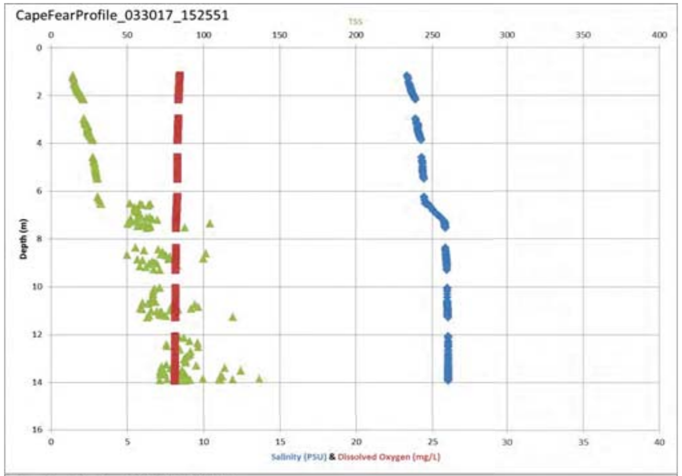
Cape Fear CTD Cast Data

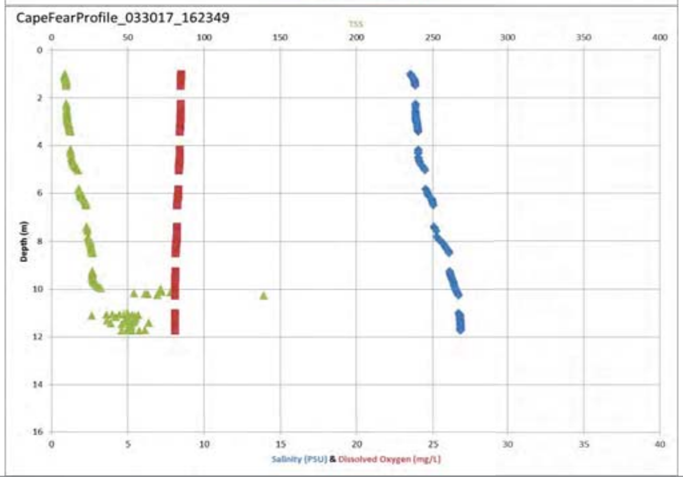
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

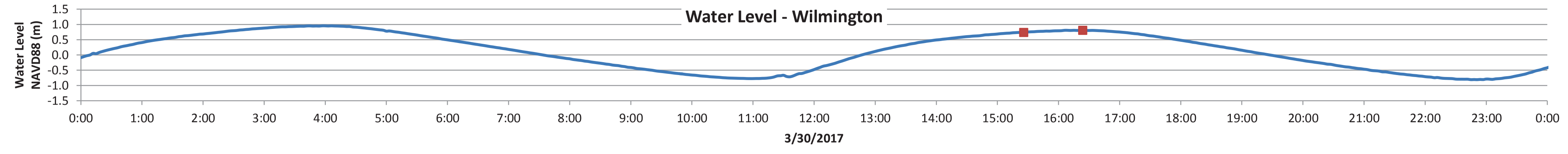
Left Bank

Center of Channel

Right Bank







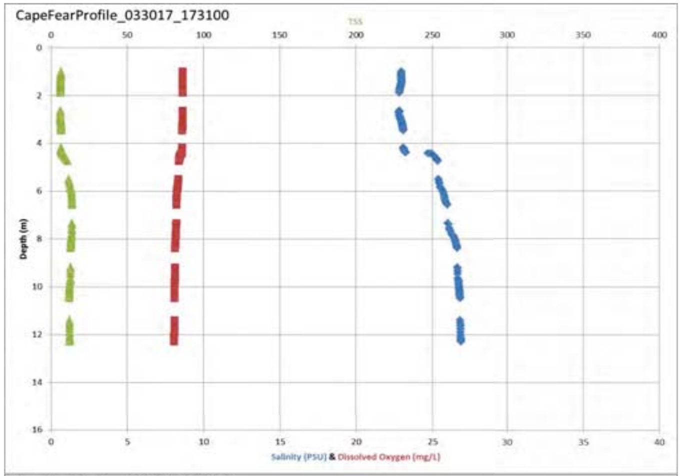
Personnel: Nate
Location: Snow's Cut

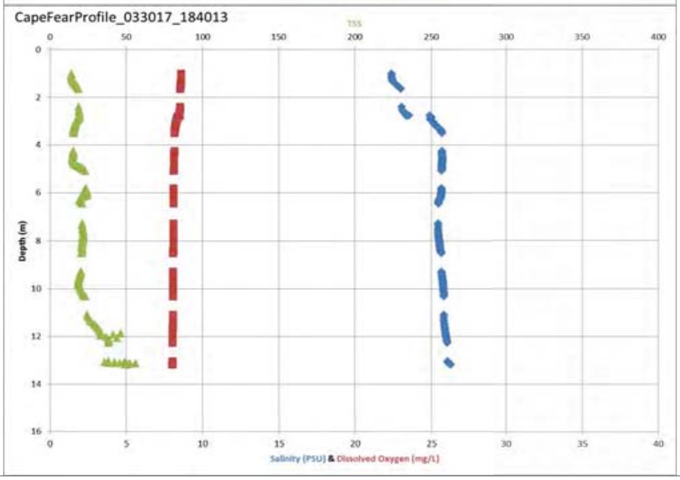
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

Left Bank

Center of Channel





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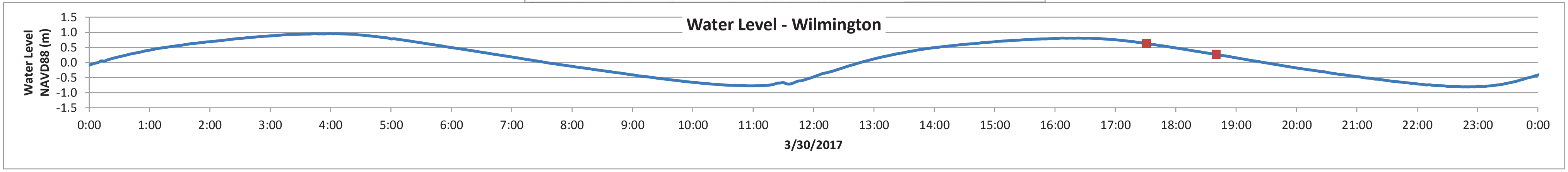
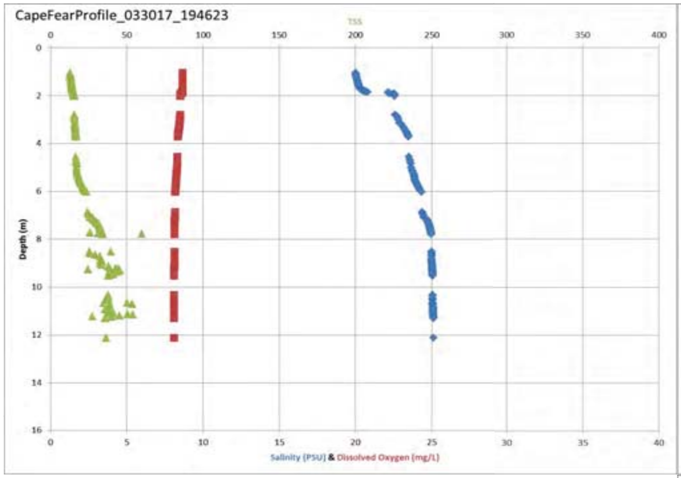


Personnel: Nate
Location: Snow's Cut

Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

Left Bank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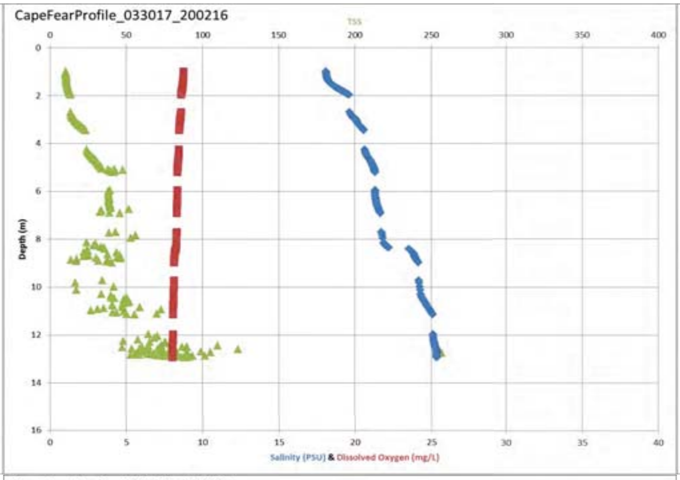
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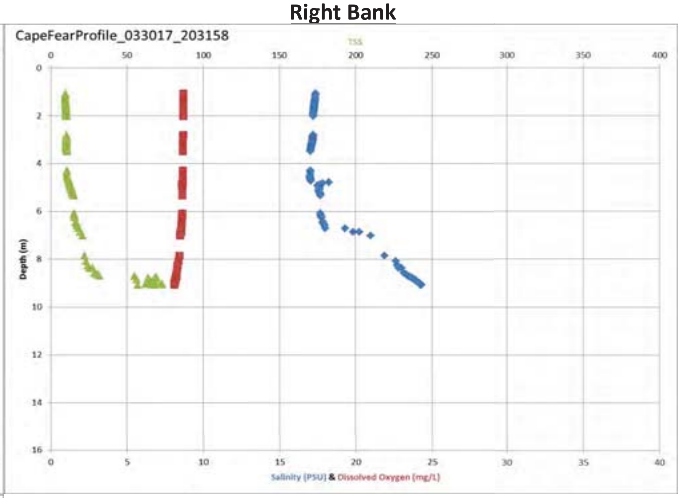
Right Bank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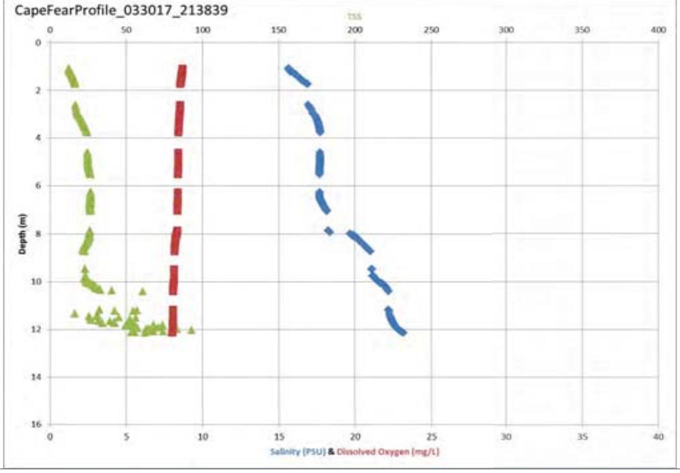
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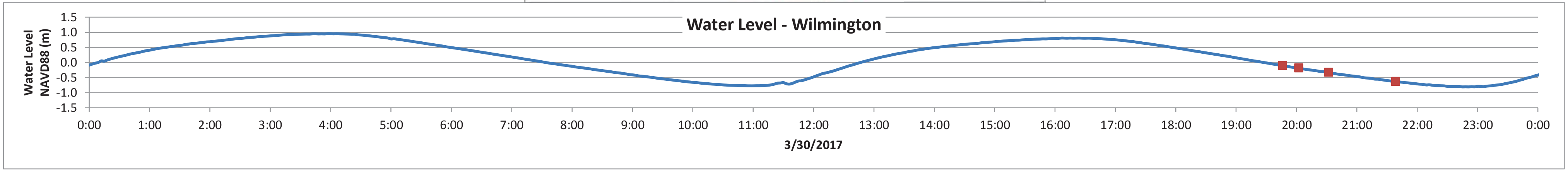

Water Level - Wilmington

Personnel: Nate
Location: Snow's Cut

Cape Fear CTD Cast Data

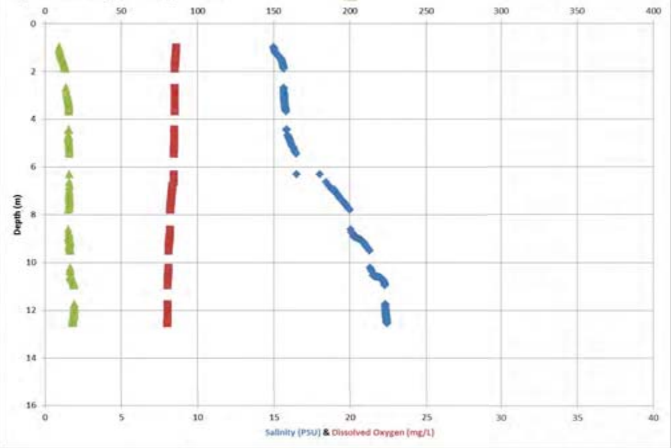
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

Left Bank

Center of Channel

Right Bank

CapeFearProfile_033017_224310



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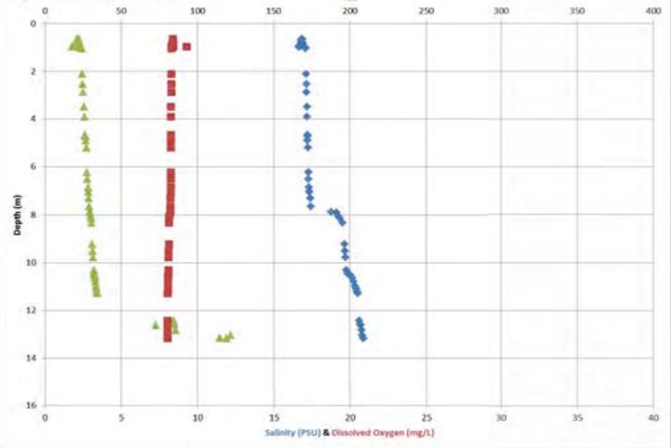
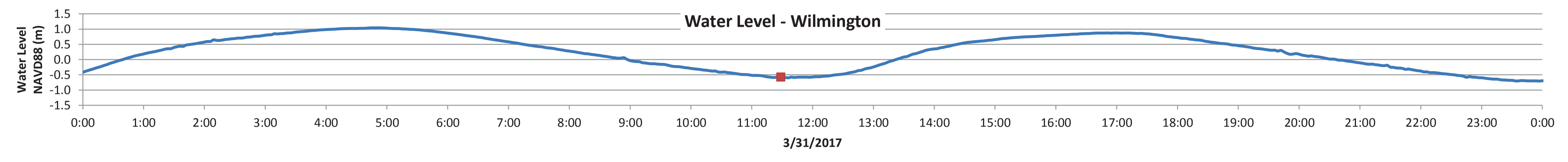




Personnel: Nate
Location: Snow's Cut

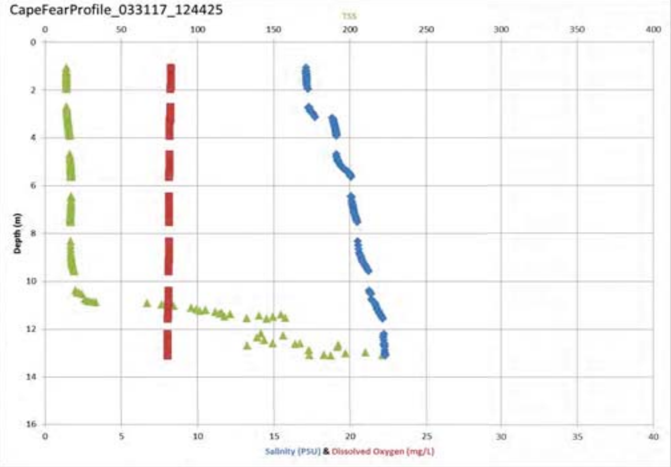
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

Left Bank

Center of Channel

Right Bank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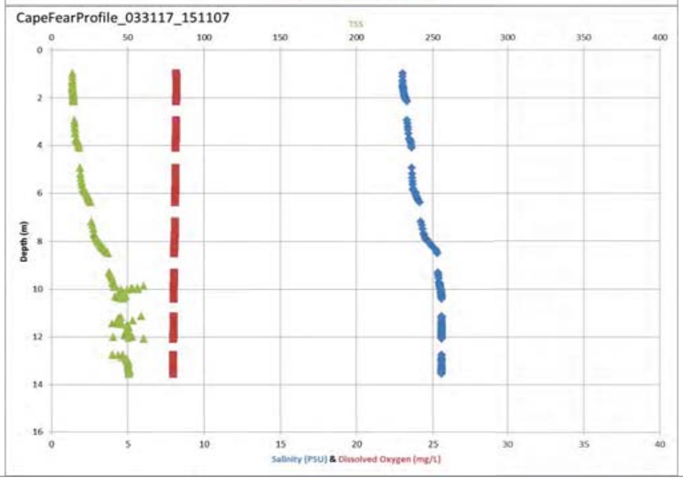
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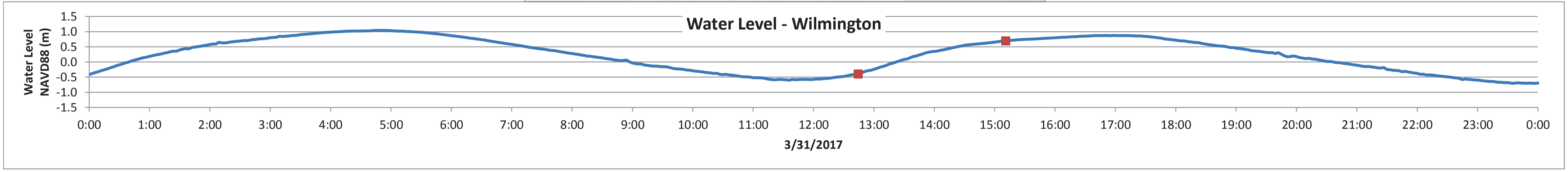

Water Level - Wilmington

Personnel: Nate
Location: Snow's Cut

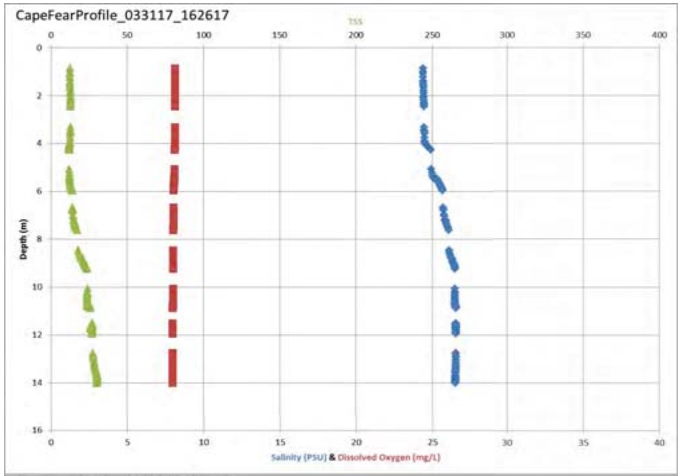
Cape Fear CTD Cast Data

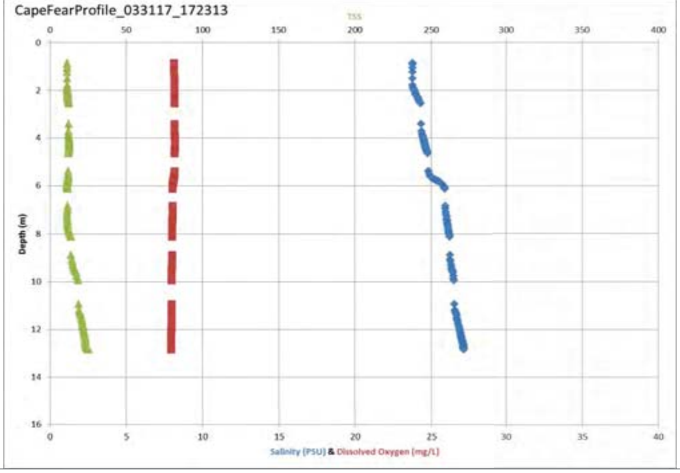
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

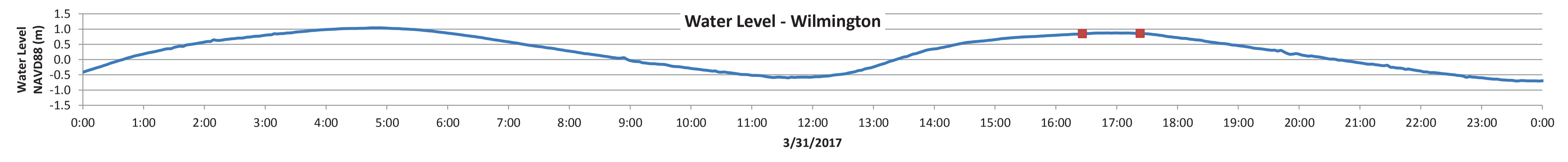
Left Bank

Center of Channel

Right Bank







Personnel: Will
Location: Southport

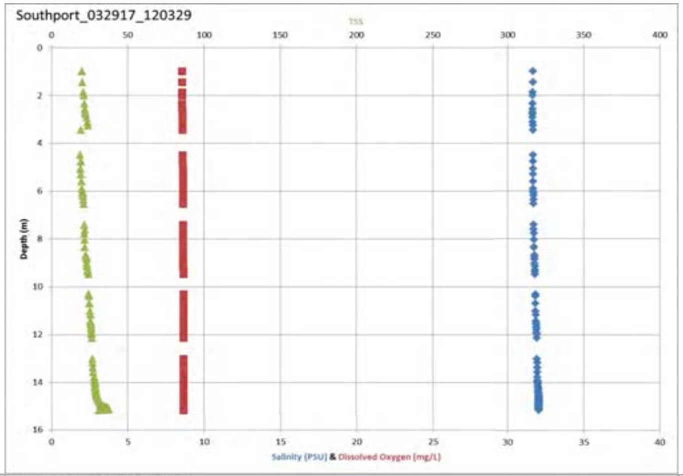
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

Left Bank

Center of Channel

Right Bank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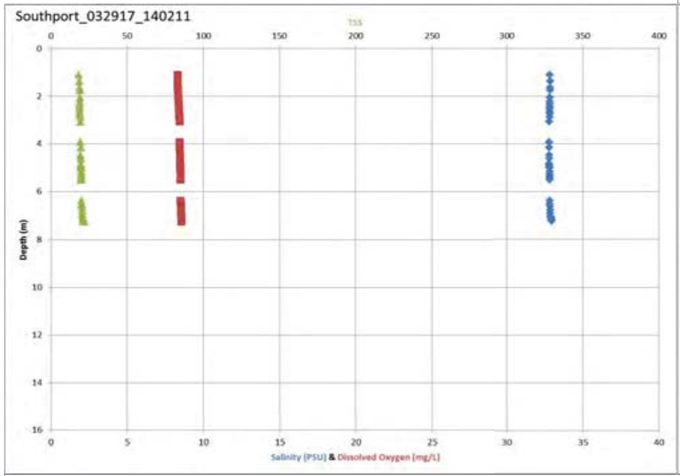
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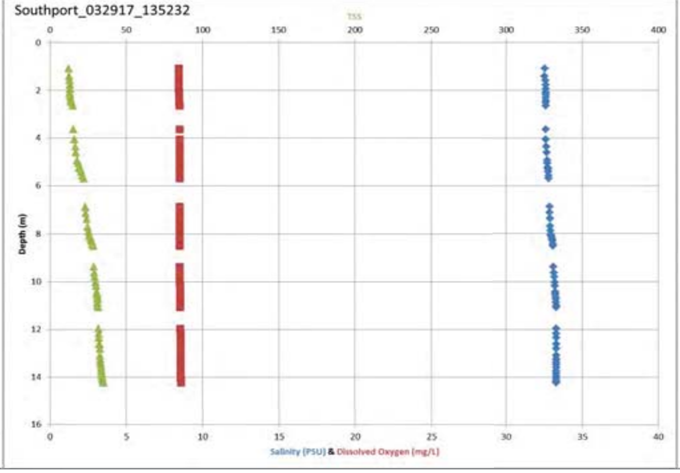
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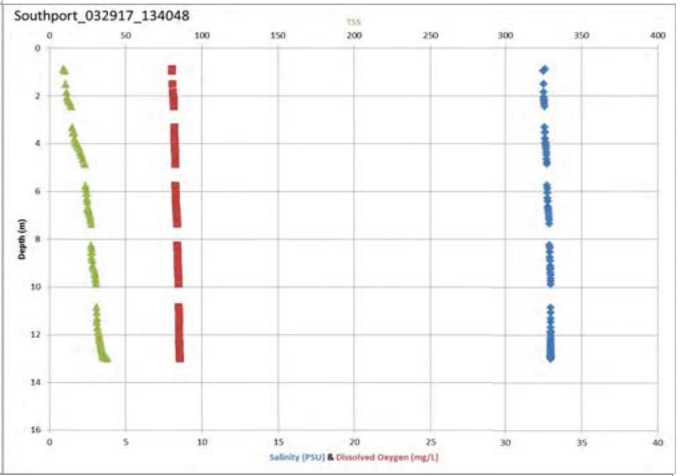
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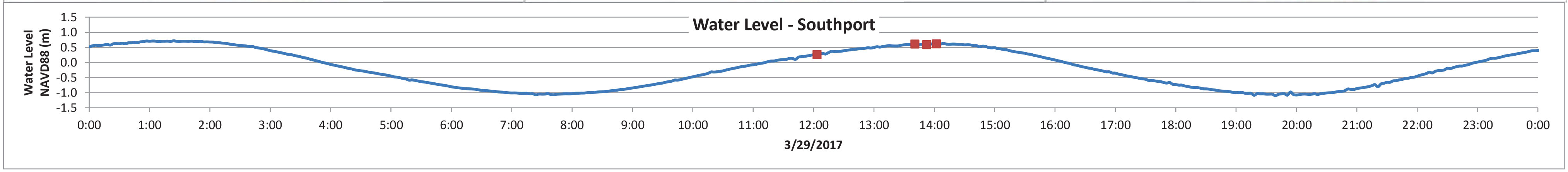

Water Level - Southport

Personnel: Will
Location: Southport

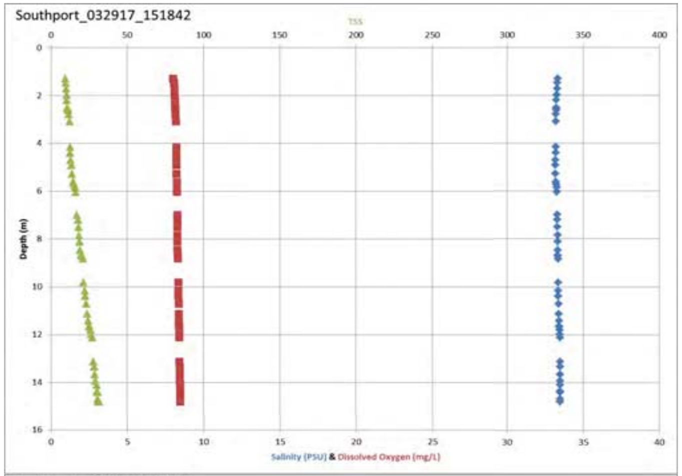
Cape Fear CTD Cast Data

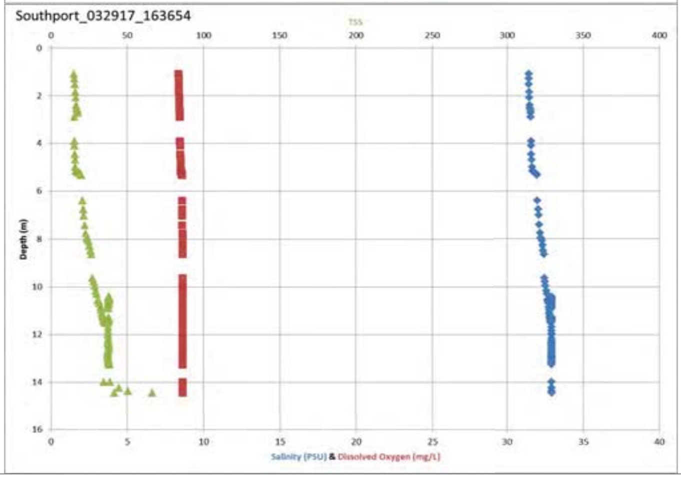
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

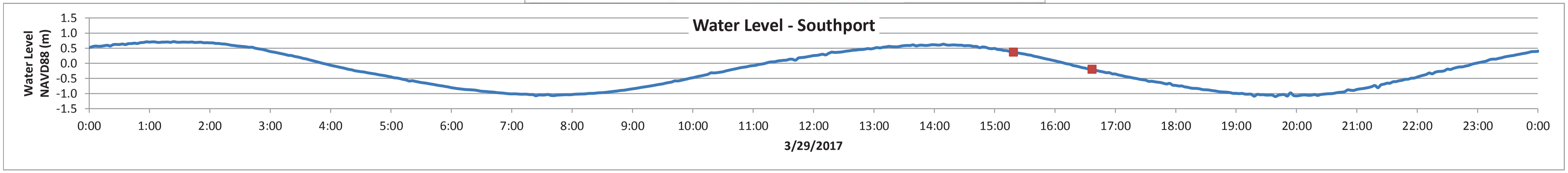
Left Bank

Center of Channel

Right Bank







Personnel: Will
Location: Southport

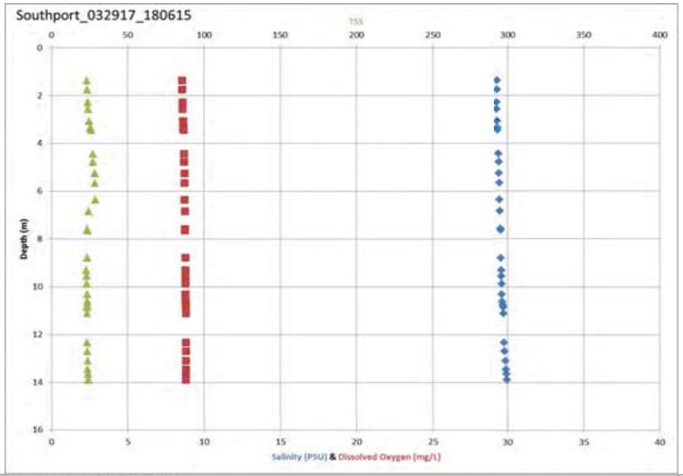
Cape Fear CTD Cast Data

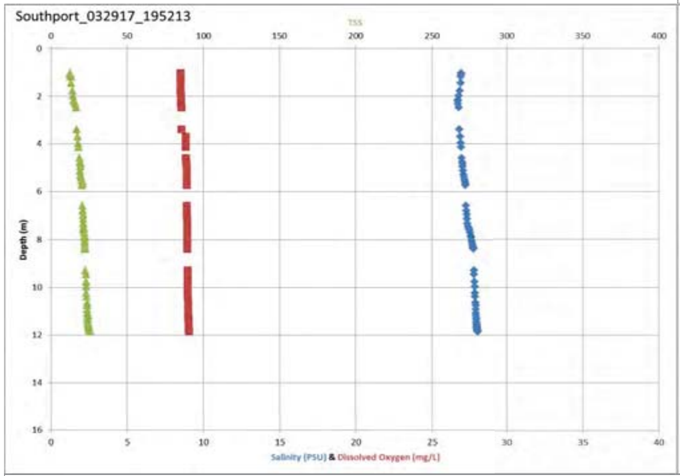
Down Casts only
🟩 TSS ◆ Salinity 🟥 Dissolved Oxygen

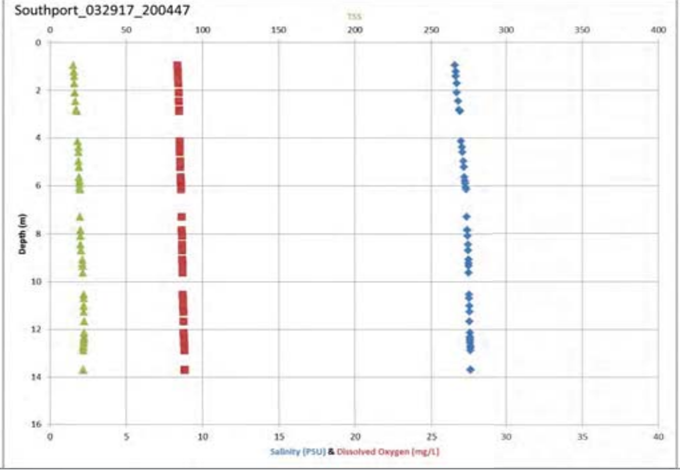
Left Bank

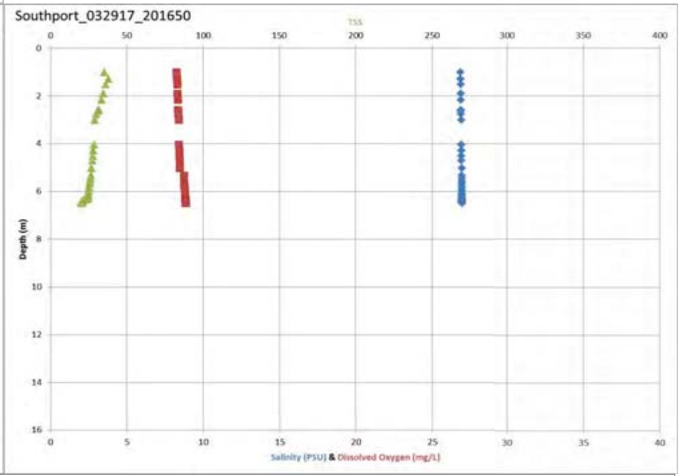
Center of Channel

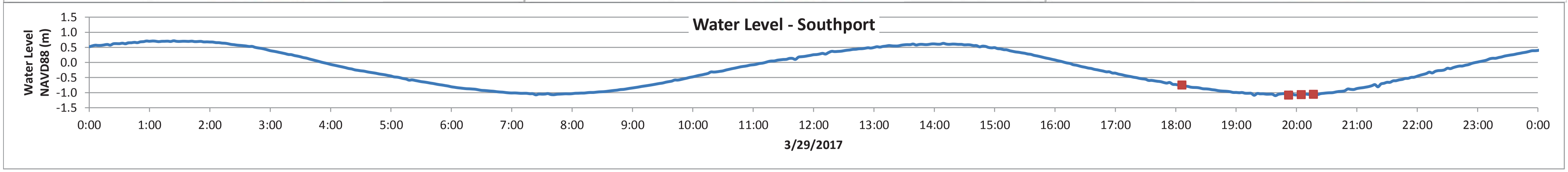
Right Bank









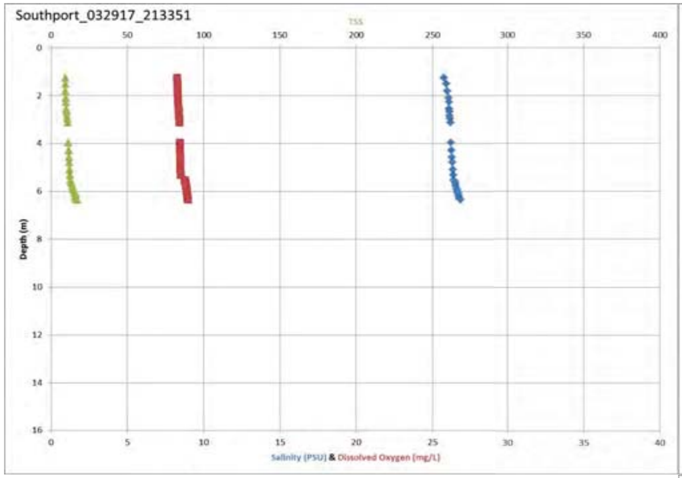


Personnel: Will
Location: Southport

Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

Left Bank



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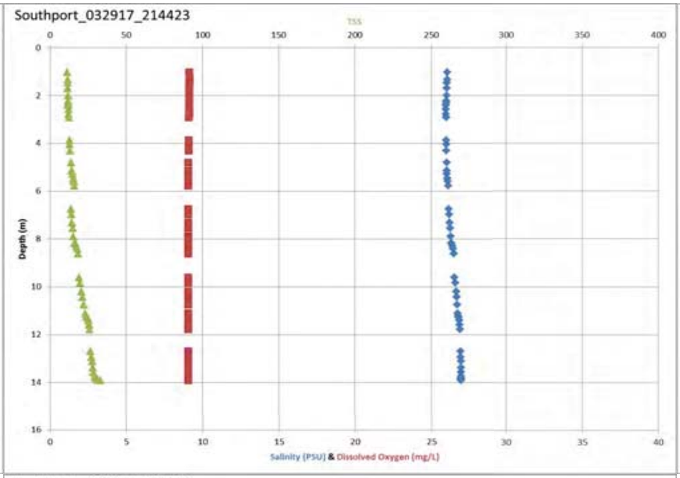
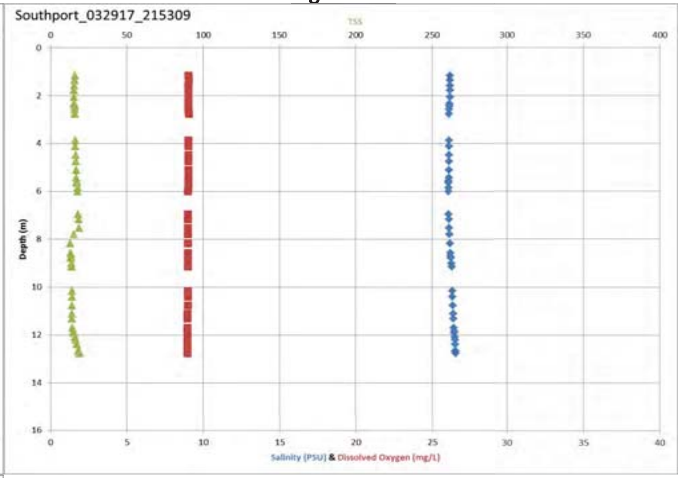
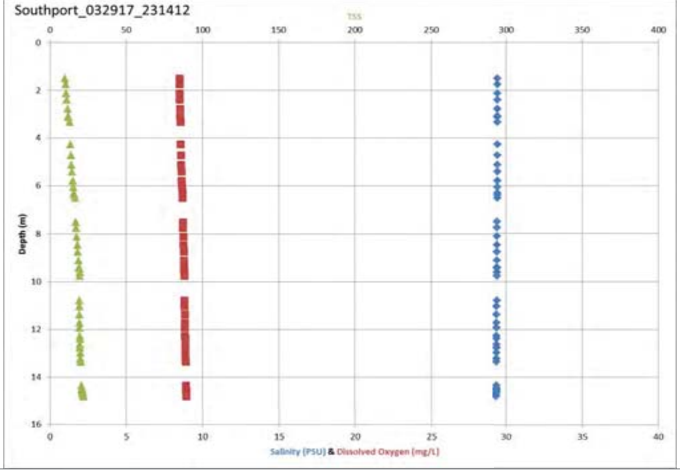
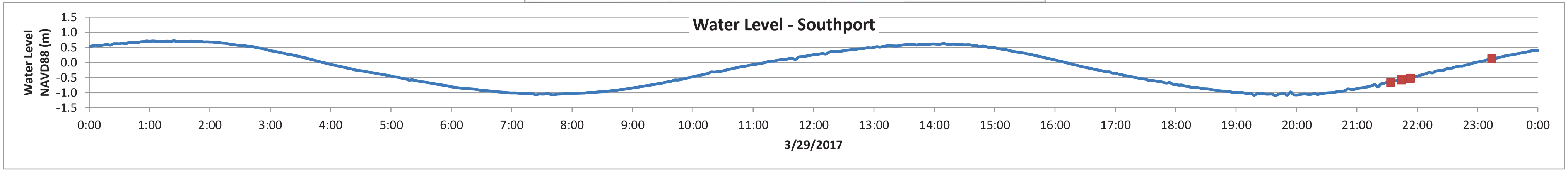


Right Bank





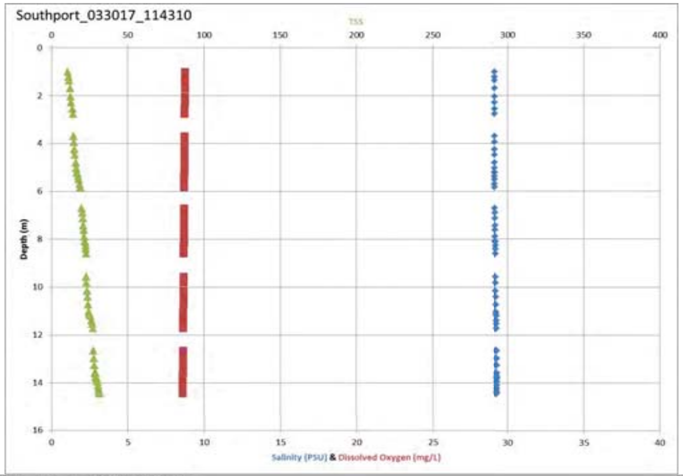


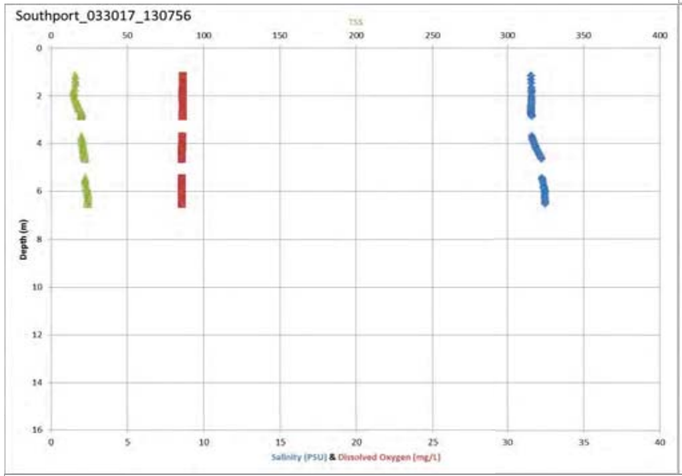
Personnel: Will
Location: Southport

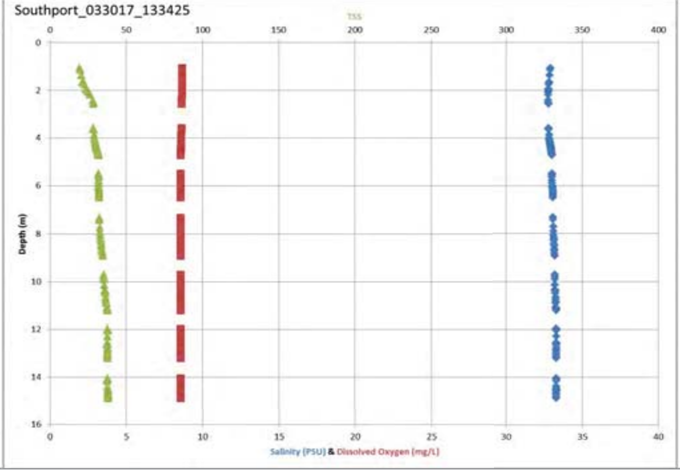
Cape Fear CTD Cast Data

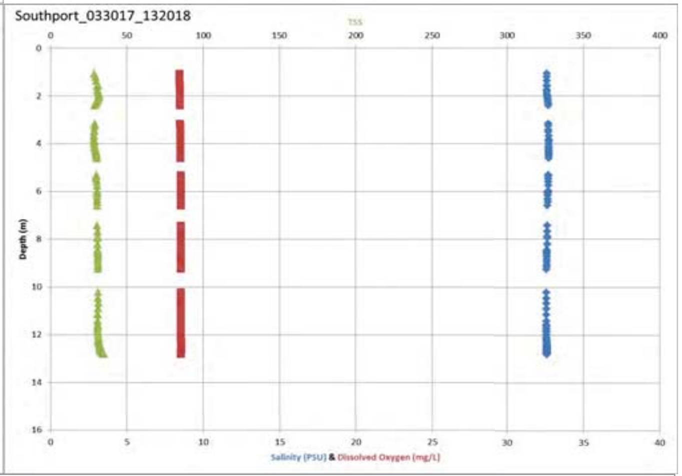
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

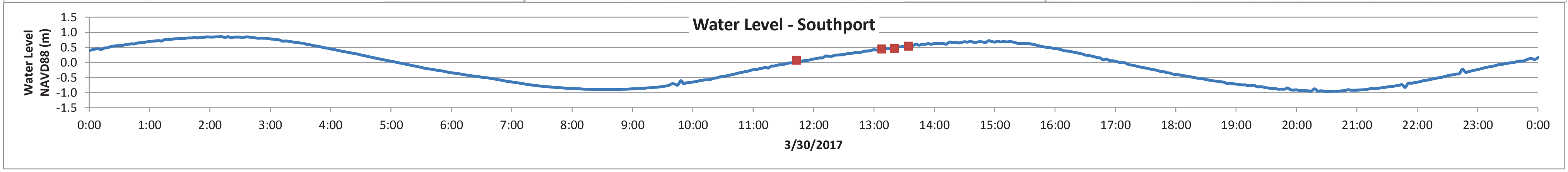
Left Bank **Center of Channel** **Right Bank**











Personnel: Will
Location: Southport

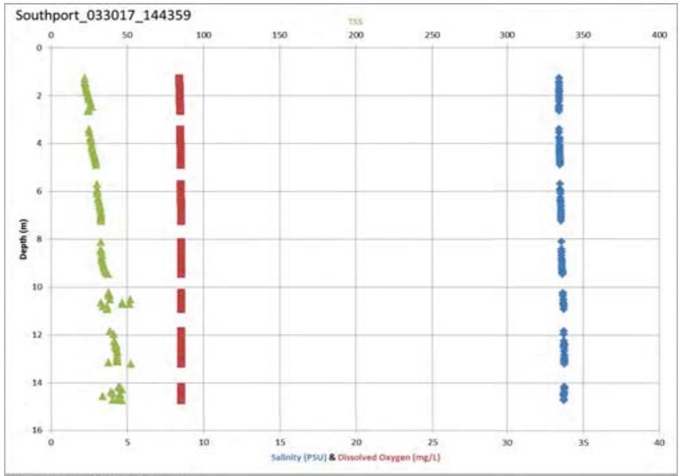
Cape Fear CTD Cast Data

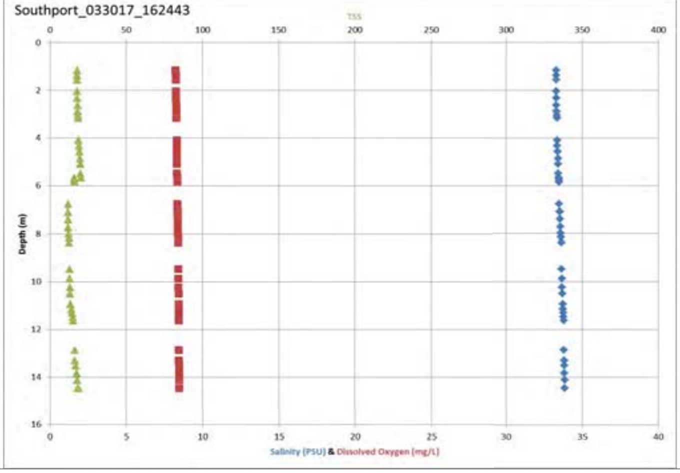
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

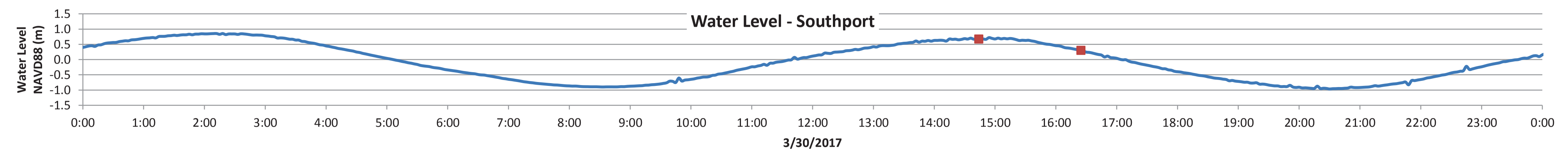
Left Bank

Center of Channel

Right Bank







Personnel: Will
Location: Southport

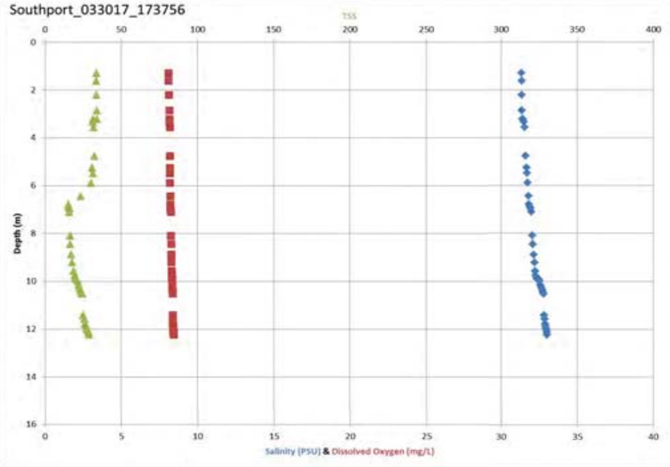
Cape Fear CTD Cast Data

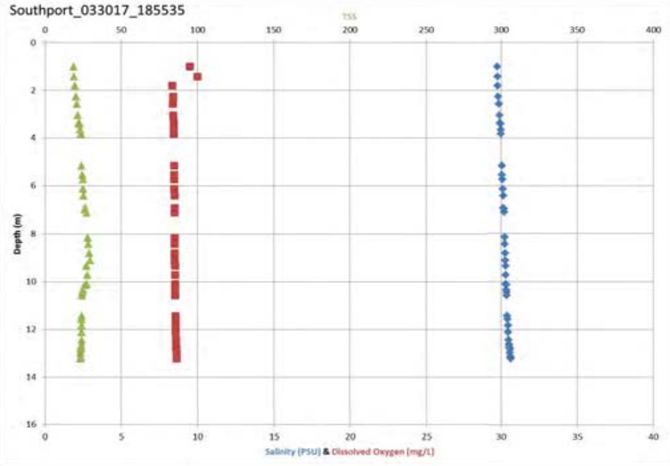
Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

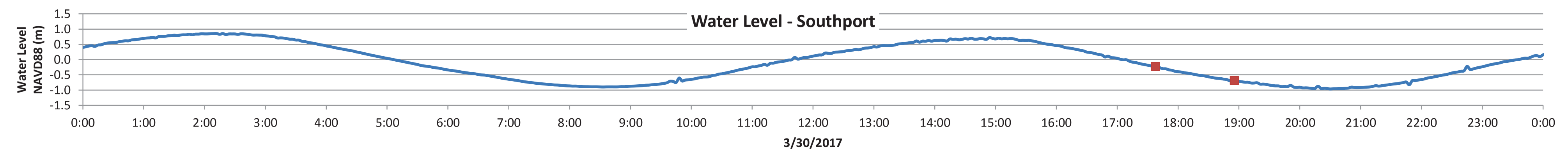
Left Bank

Center of Channel

Right Bank







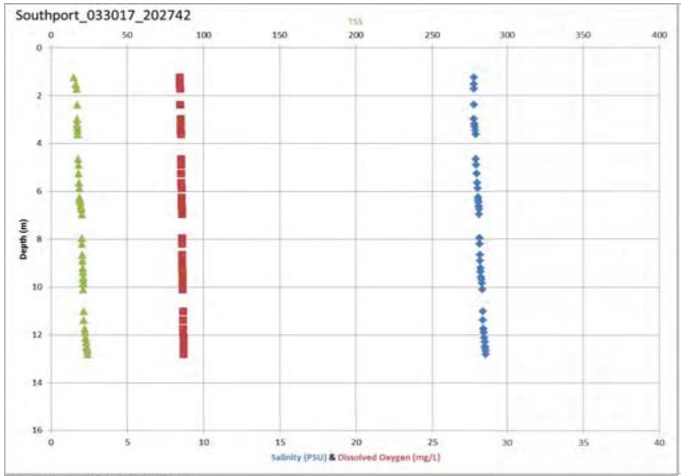
Personnel: Will
Location: Southport

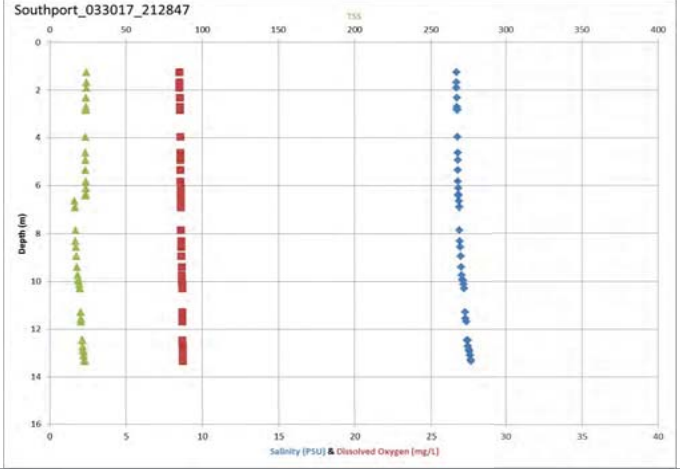
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

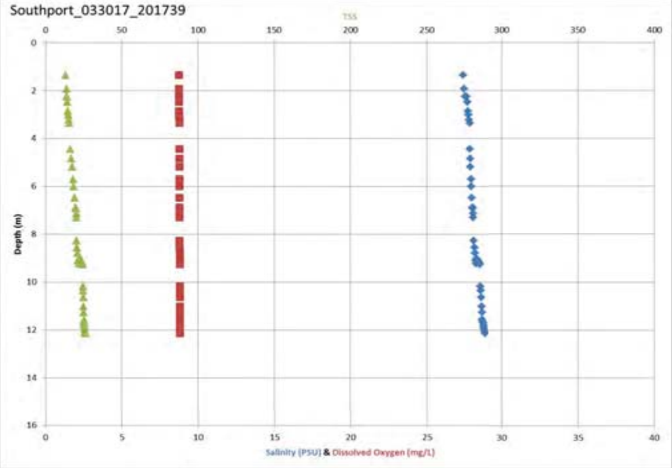
Left Bank

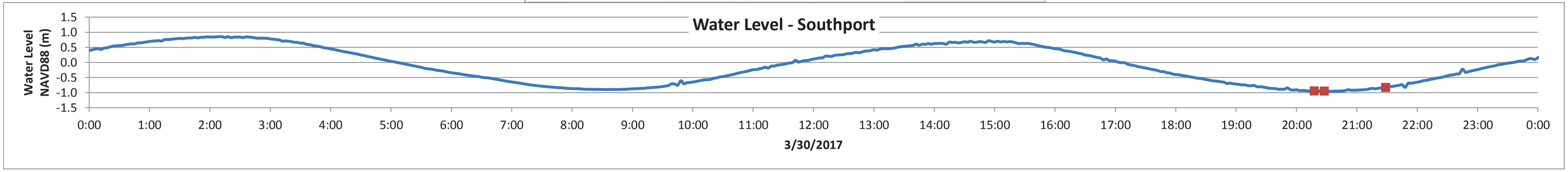
Center of Channel





Right Bank





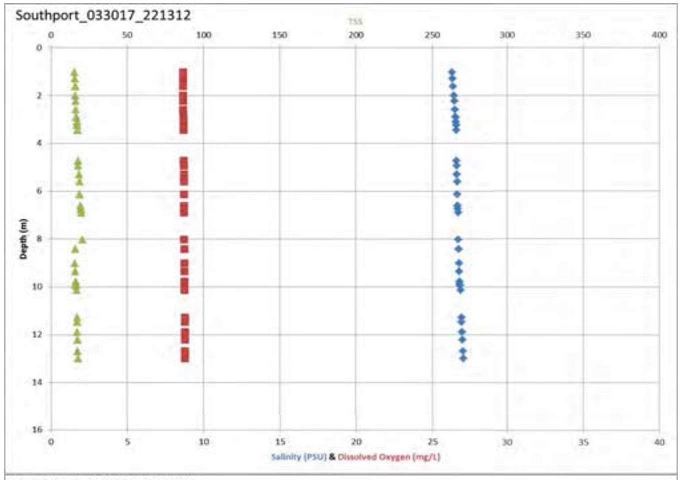
Personnel: Will
Location: Southport

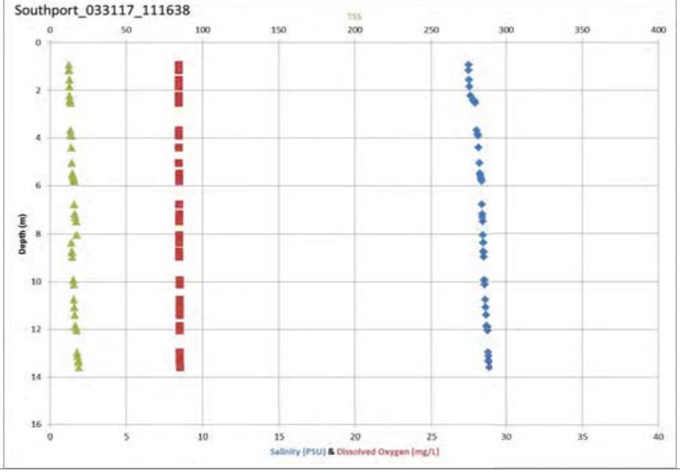
Cape Fear CTD Cast Data

Down Casts only
▲ TSS ◆ Salinity ■ Dissolved Oxygen

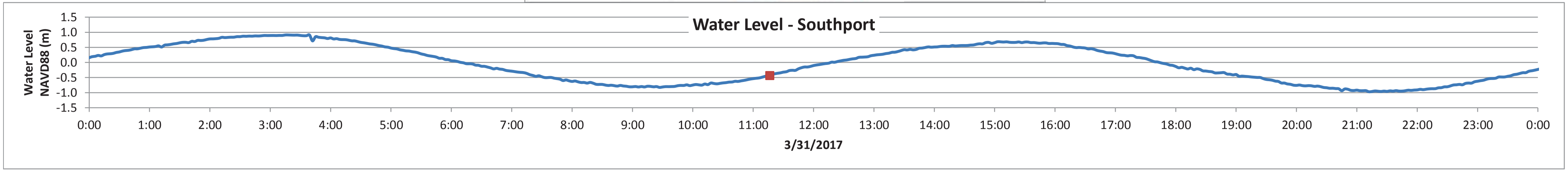
Left Bank

Center of Channel





Right Bank



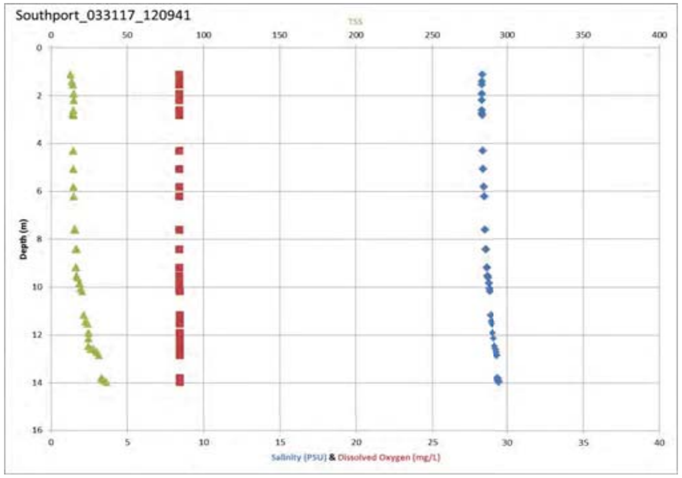
Personnel: Will
Location: Southport

Cape Fear CTD Cast Data

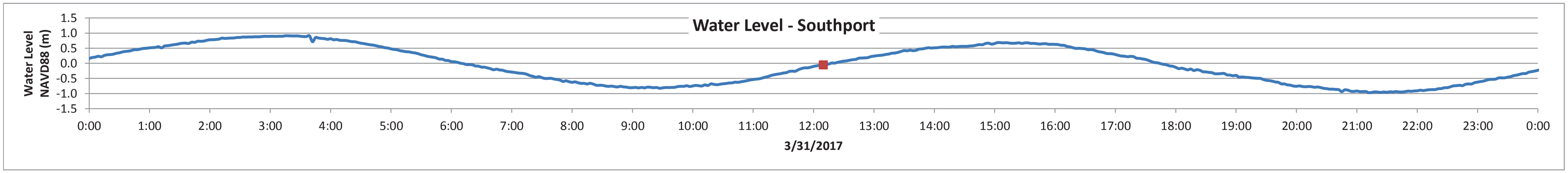
Down Casts only
▲ TSS ◆ Salinity 🟥 Dissolved Oxygen

Left Bank

Center of Channel



Right Bank



Appendix A–2:
Cape Fear WQ Study

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DATA REPORT

Cape Fear River Water Quality Study

August 8, 2017 – September 7, 2017

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APPENDICES

DATA REPORT
CAPE FEAR RIVER WATER QUALITY STUDY

1.0 INTRODUCTION

This report documents a water quality (WQ) study conducted on the Cape Fear River in North Carolina in the late summer of 2017. The study consisted of two components. The first component was the deployment of water quality instrumentation at 5 locations along the Cape Fear River for a period of one month. At each location there would be two instruments set up to record the in-situ water quality parameters at approximately 3 feet below the water surface and approximately 3 feet above the bottom. In addition to these long term deployment measurements, CTD profiles would be taken at each station immediately after deploying and before recovering each station. The second component of the study was the collection of water samples approximately 3 feet below the surface and approximately 3 feet above the bottom at each of the 5 stations. These samples were analyzed by a certified laboratory for various parameters.

2.0 WATER QUALITY STATIONS

Five stations were selected along the Cape Fear River to take continuous measurements of Dissolved Oxygen (DO), salinity, temperature and pH over a 30 day period. At each station there were two YSI EXO instruments (also referred to as sondes)installed, one approximately 3 feet below the average low water surface and another approximately 3 feet above the bottom. Each of EXO units was equipped with a DO, salinity, temperature and pH sensor. To reduce the impacts of biofouling on the measurements, each EXO sonde also had a wiper system to remove growth from the sensors and copper tape was applied to the exposed portions of the sensor cover and each sensor housing (see Photograph 1 at the end of the text). The EXOs were configured to take measurements of each parameter for one minute at 1 Hz, repeating every ten minutes. The wiper was operated every 20 minutes. The locations of the water quality and the overall depths at the station are provided in Table 1 and the locations are shown in Figure 1 at the end of the text.

Cape Fear River, NC

Table 1: Location and Water Depth at Long-Term Water Quality Stations

Station Name	Latitude	Longitude	Depth (ft)
ADM Pier Surface	33.93373°	-77.98843°	14
ADM Pier Bottom	33.93465°	-77.98602°	32
Upper Big Island Surface	34.13967°	-77.94943°	14
Upper Big Island Bottom	34.14343°	-77.95183°	36
Kinder Morgan Surface	34.21190°	-77.95469°	24
Kinder Morgan Bottom	34.21175°	-77.95472°	31
NE Cape Fear Surface	34.30452°	-77.96090°	27
NE Cape Fear Bottom	34.30452°	-77.96082°	27
CF Boat Works Surface	34.27100°	-77.99900°	20
CF Boat Works Bottom	34.27096°	-78.00043°	15

2.1 Archer Daniels Midland (ADM) Pier

The southernmost station was located at the Archer Daniels Midland (ADM) pier near Southport, NC, at the lower end of the Cape Fear River (Figure 2). The bottom instrument was installed near the ADM pier on a weighted frame as shown in Photograph 2. A recovery line was run from the frame and secured to a piling on the ADM pier. The surface instrument was originally intended to be installed on one of the steel pilings that are part of the ADM pier; however, due to the high currents at the site and the configuration of the pile, it was not possible to adequately secure the mount to the pile. Consequently, the instrument was installed on a vertical pile located approximately 700 feet southwest of the pier (Figure 2). The bottom mount was deployed at 13:35 UTC (09:35 local) on August 8, 2017 in approximately 32 feet of water. The surface mount was deployed the following day at 13:30 UTC (09:30 local) on August 9, 2017.

The recovery of the ADM instruments began in the morning of September 7, 2017. The bottom instrument was recovered first by retrieving the line secured to the pier piling, and then using it to lift the mount from the bottom with the assistance of boat's winch. The recovery of the frame and instrument was complete at 11:20 UTC (07:20 local). After recovering the bottom mount, the field team proceeded to the surface mount, and it was recovered at 11:52 UCT (07:52 local).

2.2 Upper Big Island (UBI)

The next station heading north along the Cape Fear River was in the Upper Big Island reach (Figure 3). The bottom instrument was installed on a bottom frame equipped with a Benthos 866 acoustic release system to accommodate the recovery of the mount (Photograph 3). The frame was deployed outside the western edge of the shipping channel in approximately 36 ft of water. The surface instrument at this location was installed on a steel pipe which was secured to a wooden piling with lag screws and steel banding. The wooden piling was located in approximately 14 feet of water just outside the western edge of the channel approximately 1,500 ft southeast of the bottom mount. The bottom mount was deployed at 15:22 UTC (11:22 local) on August 8, 2017, and the surface mount was deployed at 15:00 UTC (11:00 local) on August 8, 2017.

The surface instrument at the Upper Big Island instrumentation was recovered at 12:57 UTC (08:57 local) September 7, 2017. The bottom mount was recovered the same day by using a deck box to activate the acoustic release which allowed the buoy to surface, bringing with it the recovery line. The recovery line was used to the lift the mount into the boat with the assistance of a winch. The bottom mount was recovered at 13:49 UTC (09:49 local) without any complications.

2.3 Kinder Morgan Pier

The next station headed north along the Cape Fear River was at the Kinder Morgan pier which is located just north of the Port of Wilmington (Figure 4). Due to very soft sediments in this area, the bottom instrument was deployed on a short mooring with a sub-surface buoy, such that the instrument was suspended approximately 3-4 ft above the surface of the sediments (Photograph 4). A ground line was run from the mooring anchor over to a set of nearby pilings for recovery. The surface instrument at this location was mounted on a steel pipe which was secured to a wooden piling with lag screws and steel banding. The piling that the surface instrument was mounted on was approximately 35 feet east of the bottom mount. The bottom mount was deployed at 16:10 UTC (12:10 local) on August 8, 2017 in approximately 31 feet of water. The surface mount was deployed at 17:00 UTC (13:00 local) on August 8, 2017.

The recovery of the Kinder Morgan Pier instrumentation began in the morning of September 7, 2017, with the recovery of the surface instrument 14:13 UTC (10:13 local). The bottom instrument was recovered at 14:25 UTC (10:25 local) using the ground line that had been secured to the piling to lift the anchor and then the instrument and sub-surface buoy onto the vessel (Photograph 5).

2.4 Northeast Cape Fear River

The next station headed north was located in the Northeast Cape Fear River which is a tributary of the Cape Fear River that joins the Cape Fear in downtown Wilmington. The water quality station was located approximately 5 miles up the Northeast Cape Fear from the river’s confluence with the Cape Fear River (Figure 5). The bottom instrument was mounted on a frame similar to what was used at the other sites. A ground line was run from the frame and secured above the surface to a nearby piling to allow for recovery of the instrument. The surface instrument at this location was mounted on a steel pipe which was secured to a wooden piling with lag screws and steel banding. The bottom mount was deployed at 18:02 UTC (14:02 local) on August 8, 2017 in approximately 27 feet of water. The surface mount was deployed at 18:20 UTC (14:20 local) on August 8, 2017.

The recovery of the Northeast Cape Fear River instrumentation took place on September 7, 2017 with the bottom mounted instrument recovered first at 15:35 UTC (11:35 local). Next, an attempt was made to recover the surface mounted instrument, however, the water level was too high and the lower lag screw holding the pipe to the pile was inaccessible from the work boat. The field team continued on to another station and returned to the Northeast Cape Fear to recover the surface instrument at

17:35 UTC (13:35 local) once the tide had gone down sufficiently to allow access to the lag screws.

2.5 Cape Fear Boat Works

The final station, the northernmost along the Cape Fear River, was located at Cape Fear Boat Works which is about 4 miles upriver from the confluence of the Cape Fear River with the Northeast Cape Fear River (Figure 6). The bottom instrument at this location was installed inside an aluminum cage and then suspend by a Kevlar rope from a fixed dock at the Cape Fear Boat Works. Weights were suspended below the cage to keep the mount from swinging with the currents. The surface instrument at this location was mounted on a steel pipe which was secured to a wooden piling with lag screws and steel banding. The bottom mount was deployed at 20:15 UTC (16:15 local) on August 8, 2017 in approximately 15 feet of water and the surface mount was deployed at 19:31 UTC (15:31 local) on August 8, 2017. It had been intended to deploy the bottom sensor deeper, but it was not possible to do so given that the depths adjacent to the pier which were shallower than previously reported.

The recovery of the Northeast Cape Fear River instrumentation took place on September 7, 2017. The surface instrument was recovered was recovered at 16:33 UTC (12:33 local) bottom instrument was recovered at 16:46 UTC (12:46 local).

3.0 CTD CASTS AND WATER SAMPLING

CTD casts were performed using an YSI EXO water quality sonde with dissolved oxygen, salinity, temperature, pH and Chlorophyll sensors. A cast was taken adjacent to each long-term sensor location after the installation and prior to the recovery of each instrument system. Additionally, after deployment of the instrumentation, several rounds of CTD casts were taken at points along the Cape Fear & Northeast Cape Fear Rivers just north and south of downtown Wilmington during the flood tide on the morning of August 10, 2017. The cast were taken at 18 stations spaced at equal intervals of approximately 1 kilometer along the centerlines of the rivers as shown in Figure 7. At each of the 18 stations, 2 or 3 CTD profiles were collected at different times in the flood tidal cycle to provide an indication of how the water quality conditions in this section of the river changed during that time period.

Water samples were collected using a Niskin bottle at each of the water quality stations. As with the CTD casts, these samples were taken next each of the water quality stations after deployment and prior to recovering the instrumentation. For each water sampling event, water samples were collected approximately 3 feet below the water surface and 3 feet above the bottom. Water samples were placed into clean sample bottles provided by the analytical laboratory and labeled with the station location, depth, date and time. The bottles were then placed into coolers and iced for transport to the laboratory for analysis of the specified parameters.

4.0 PROCESSING AND RESULTS OF DATA

The processing of the data and the results are described below. Please note that all times provided are in UTC.

4.1 Water Quality Data from Fixed Stations

As previously discussed, each of the five locations had two water quality sensors: a near bottom water quality station collecting data from approximately 3 feet above the bottom and a near surface water quality station approximately 3 feet below mean low water. Upon recover of the instruments, the raw binary data was downloaded from the YSI EXOs using YSI KOR-EXO software and then converted to an ASCII format using YSI software. The data was then processed and analyzed using in-house analysis tools.

Upon reviewing the data, it was determined that 5 of the instruments had recorded complete data sets over the deployment period, 2 of the instruments had recorded data for approximately 25 days, 2 of the instruments had recorded data for approximately 21 days and one of the instruments failed immediately after deployment. Table 2 summarizes the data collected at the 5 stations.

For the stations that failed to collect a complete data set, analysis of the system logs indicates that the instruments consumed power at a much higher rate than anticipated and ran out of power sooner than calculations indicated they should. After discussions with the manufacturer of the EXO units, it is speculated that the biofouling may have caused the wiper to draw more power than is typical, and resulting in the premature depletion of the batteries in the instruments. Figure 6 is the sonde from UBI surface and illustrates the amount of biofouling that occurred.

The failure of the surface instrument at CFBW appears to be related to a communication issue with one of the sensors after the instrument was deployed, possibly due to water leaking into the fitting where the sensor connects to the instrument. Due to the communication problem, the instrument kept attempting to rest itself until it eventually shutdown.

Table 2: Summary of Data Collected by Long-term Water Quality Sensors

Station Name	Start of Data Set (UTC)	End of Data Set (UTC)	Comments
ADM Pier Surface	8/9/2017 13:30	9/7/2017 11:50	Full Data Set
ADM Pier Bottom	8/8/2017 13:40	9/7/2017 11:10	Full Data Set
Upper Big Island Surface	8/8/2017 14:50	8/29/2017 22:50	22 days of data – low batteries
Upper Big Island Bottom	8/8/2017 15:30	8/28/2017 15:20	21 days of data – low batteries
Kinder Morgan Surface	8/8/2017 17:00	9/2/2017 13:50	26 days of data – low batteries
Kinder Morgan Bottom	8/8/2017 16:10	9/7/2017 14:20	Full Data Set
NE Cape Fear Surface	8/8/2017 18:20	9/3/2017 18:20	27 days of data – low batteries
NE Cape Fear Bottom	8/8/2017 18:10	9/7/2017 15:30	Full Data Set
CF Boat Works Surface	8/8/2017 19:30	8/8/2017 19:30	No Data
CF Boat Works Bottom	8/8/2017 20:20	9/7/2017 16:40	Full Data Set

As noted previously, the instruments were configured to collect data at 1 Hz over a 60 second period every 10 minutes. As part of the post processing, all of the data for each parameter over the 60 second period were averaged and the averaged results are shown in the results of the long-term water quality measurements presented in Appendix I. Excel data files of the averaged data also accompany this report.

4.2 Water Sampling

The water samples collected after deployment and before recovery of the stations were analyzed for a variety of parameters by a certified laboratory. The surface samples were analyzed for nitrogen, phosphorus, dissolved particulate organic carbon, and biological oxygen demand (BOD) and the near-bottom samples were analyzed for dissolved/particulate organic carbon and biological oxygen demand. Dissolved oxygen and Chlorophyll were measured in situ using a profiling instrument. The results of the laboratory analysis of the samples and the measurements from the profiling instruments are provided in Table 3. The certificates of analysis for the analysis of the samples are provided in Appendix II

Please note that for the water samples collected during the deployment, all of the analysis on the water samples was conducted by General Engineering Laboratories (GEL). GEL also conducted all of the analysis on the water samples taken at the recovery of the instruments except for the BOD. BOD has a very short holding time, and GEL was closed due to Hurricane Irma when the samples were collected. Consequently, it was necessary to get the BOD analysis done by a laboratory in Wilmington to meet the holding times of the method.

4.3 CTD Casts

Plots of the CTD data from the casts collected after the installation of the instrument are provided in Appendix III, and plots of the casts from the recovery are provided in Appendix IV. The plots of the data from the centerline CTD cast collected on August, 2017 are shown in Appendix V. Please note that the data shown in the plots is from the downcast only. The gaps in the profile observed in some of the casts was the result of a data buffering issue of the data transfer within the CTD. ASCII files of the CTD data accompany this report.

Cape Fear River, NC

Table 3: Results of Analysis of Water Samples

Station	Position	Date	Time	TKN	Nitrate/ Nitrite	Total Phosporus	Total Nitrogen	BOD	Dissolved Organic Carbon	Depth below surface*	DO*	Chlorphyll *
				mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	m	mg/L	µg/L
ADM Pier	S	8/9/2017	10:23	0.772	0.0137	<.02	786	1.08	0.915	1.15	5.46	3.82
ADM Pier	B	8/9/2017	10:12					1.03	0.835	9.18	5.52	4.47
Upper Big Island	S	8/9/2017	12:54	0.626	0.266	0.0524	892	2.35	3.57	0.9	5.2	6.61
Upper Big Island	B	8/9/2017	13:08					1.92	2.51	7.14	5.16	6.15
Kinder Morgan	S	8/9/2017	13:30	0.626	0.304	0.0676	930	2.29	4.42	1.17	4.48	6.09
Kinder Morgan	B	8/9/2017	13:37					3.02	3.46	9.62	4.15	6.74
NECF	S	8/9/2017	14:51	0.574	0.176	0.0406	750	2.45	9.97	1.2	4.85	7.65
NECF	B	8/9/2017	14:56					1.97	7.46	6.77	4.67	6.95
CF Boat Works	S	8/9/2017	14:21	0.556	0.41	0.128	966	1.15	9.96	1.12	4.59	6.24
CF Boat Works	B	8/9/2017	14:17					1.24	6.07	9.2	4.13	5.66
ADM Pier	S	9/7/2017	7:58	1.1	0.0757	0.0634	1180	1.8	1.88	1.28	5.67	5
ADM Pier	B	9/7/2017	7:25					1.8	1.98	9.22	5.57	4.86
Upper Big Island	S	9/7/2017	8:45	1.07	0.255	0.13	1330	1.4	10.5	1.11	5.1	8.14
Upper Big Island	B	9/7/2017	9:20					<1	7.24	7.31	5.15	7.97
Kinder Morgan	S	9/7/2017	10:04	0.7665	0.244	0.154	1010	<1	16	1.04	4.47	9.18
Kinder Morgan	B	9/7/2017	9:58					<1	13.6	7.69	4.04	8.99
NECF	S	9/7/2017	11:12	0.972	0.0807	0.407	1050	<1	26.7	1.04	4.88	11.86
NECF	B	9/7/2017	11:22					<1	28.8	8.43	4.24	11.76
CF Boat Works	S	9/7/2017	12:25	0.64	0.435	0.231	1080	<1	13.8	1.04	4.83	6.18
CF Boat Works	B	9/7/2017	12:12					<1	14.3	10.53	4.85	5.68

* From profiling CTD

5.0 DISCUSSION

Overall, the data from the long-term deployment looks reasonable and consistent with the trends you would expect at each location. Comments on the individual stations are provided below.

ADM Pier

Data from the deployed sensors looks reasonable over the first two weeks with surface salinities running slightly lower than the bottom salinities. The data from the CTD profile collected just after the deployment are consistent with the values measured by the long-term sensors. Starting on approximately August 22, 2017, the salinity values measured by the surface sensor start to decrease noticeably relative to those measured by the bottom sensor and remain low until the end of the deployment. The pH measured by the surface sensor also show a slight offset from the bottom one starting about the same time. A comparison of the salinity data measured by the bottom and surface sensors relative to the CTD cast collected at the end of the deployment indicates that the surface salinity sensor had drifted and that the results are approximately 5 ppt lower than what they should be. Despite the anti-fouling measures employed, the surface sensor at this location had experienced significant fouling which likely caused the drift in the salinity measurements and the pH measurements after approximately August 22.

UBI

The surface and bottom salinity levels at UBI have similar variations that correlate with the tidal stage; however, the surface values are lower by approximately 5 ppt. The DO levels also show a strong tidal signal. The values measured in the CTD cast after the deployment corresponds well with those measured by the long term sensors. Since the instruments stopped recording before the end of the deployment, a comparison with the CTD cast at the recovery is not possible. The only significant anomaly observed in the results is a jump in the water depth of approximately 0.5 meters for approximately 8 hours occurring around 20:00 on August 12. It is unclear what caused this jump, though one possibility is some type of marine organism may have temporarily covered the depth sensor port. There is no indication any of the other measurements were impacted during this time.

KM

The surface and bottom salinity levels at KM have similar variations that correlate with the tidal variations similar to the measurements at ADM and UBI. The salinities at the bottom are higher than the surface whereas DO levels at the surface are higher than the bottom. The measurements from the CTD cast at the deployment are consistent with what was measured by the long-term stations at the corresponding time. The data from the long-term sensors looks reasonable throughout the deployment. In the latter part of the deployment, the bottom salinities show increasing large variations over the tidal cycle and the surface pH also shows an increase of the bottom pH which seemed a little unusual. However, the values from the long term bottom sensor compared well with the measurements taken during the CTD cast upon recovery.

NECF

The surface and bottom salinity levels at the NECF are quite comparable in their range and values over the course of the deployment. The surface DO is slightly higher throughout the deployment. The data from the CTD cast at the deployment is in good agreement with the measurements recorded with the long-term sensors. At the recovery, only the bottom sensor was working and the results from that sensor also were in good agreement with the CTD cast.

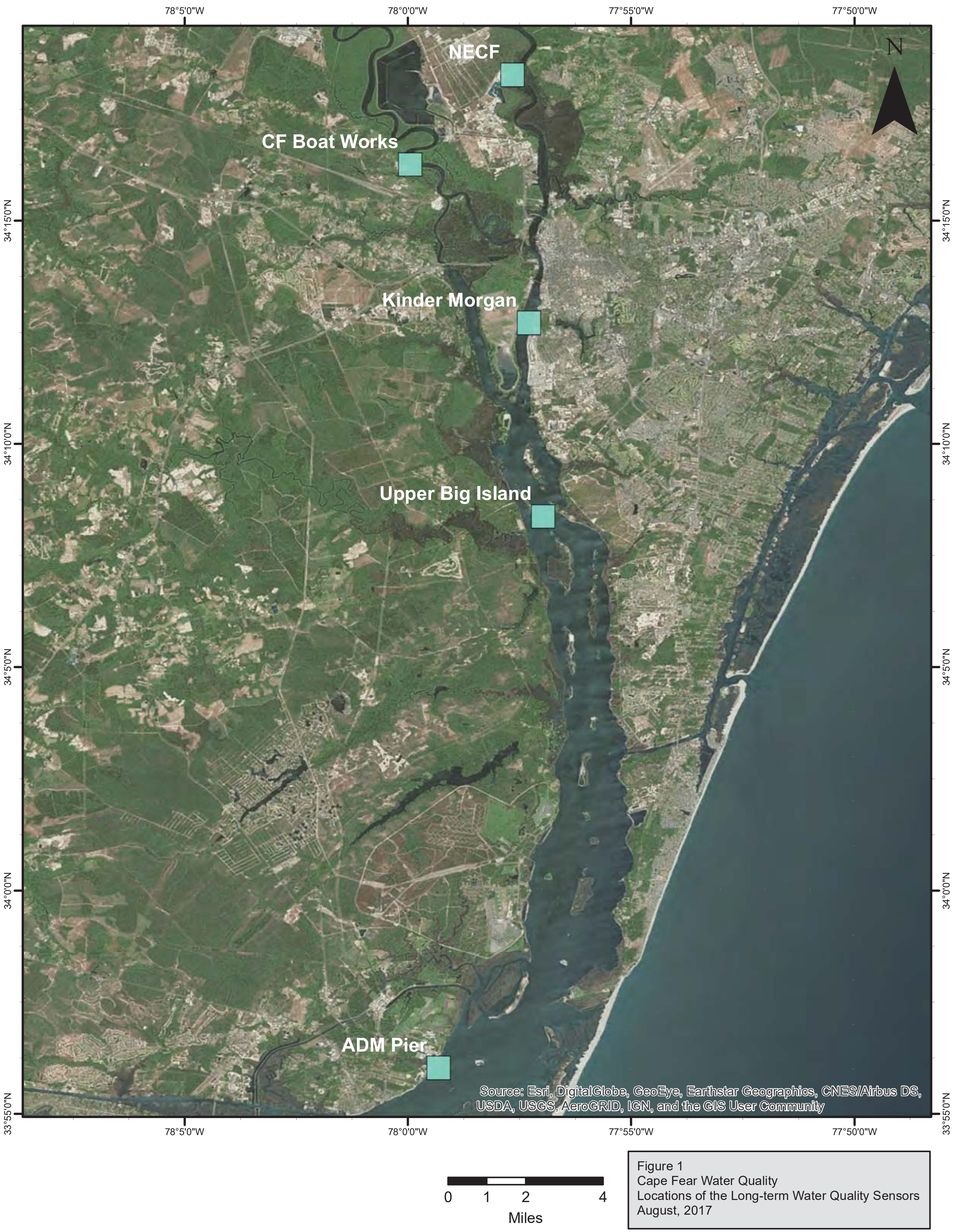
CFBW

As discussed previously, the surface sensor at the CFBW station failed upon deployment so the only available long-term data is from the bottom sensor. Because of the limited deployment options at this site, the depth of this sensor was only approximately 3 meters at low tide. The salinity signal at this location was very tidal dependent and decreased to only a very small pulse at high tide during the middle of the deployment

Cape Fear River, NC

and then began increasing again in the latter half of the deployment. The DO levels also showed a tidal signal. The data from the CTD cast taken after the deployment was in good agreement with measurements from the long-term sensor. The data from the CTD cast at the recovery was also in good agreement with the long-term sensor data.

FIGURES



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 1
Cape Fear Water Quality
Locations of the Long-term Water Quality Sensors
August, 2017

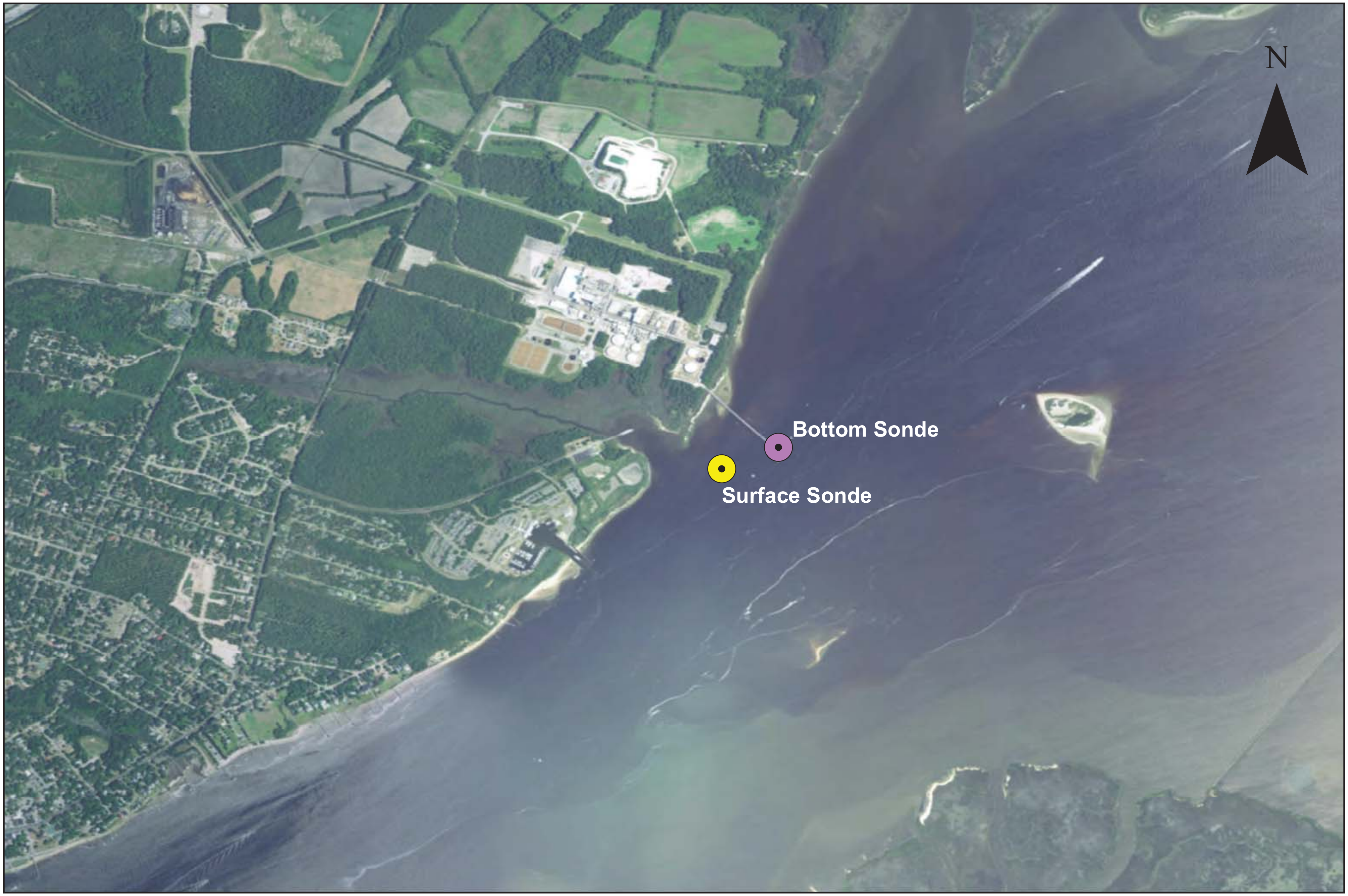


Figure 2
Cape Fear Water Quality Study
Archer Daniel Midlands (ADM) Pier
August 2017

Figure 3
Cape Fear Water Quality Study
Upper Big Island (UBI)
August 2017

Figure 4
Cape Fear Water Quality Study
Kinder Morgan (KM)
August 2017

Figure 5
Cape Fear Water Quality Study
Northeast Cape Fear River (NECF)
August 2017

Figure 6
Cape Fear Water Quality Study
Cape Fear Boat Works (CFBW)
August 2017

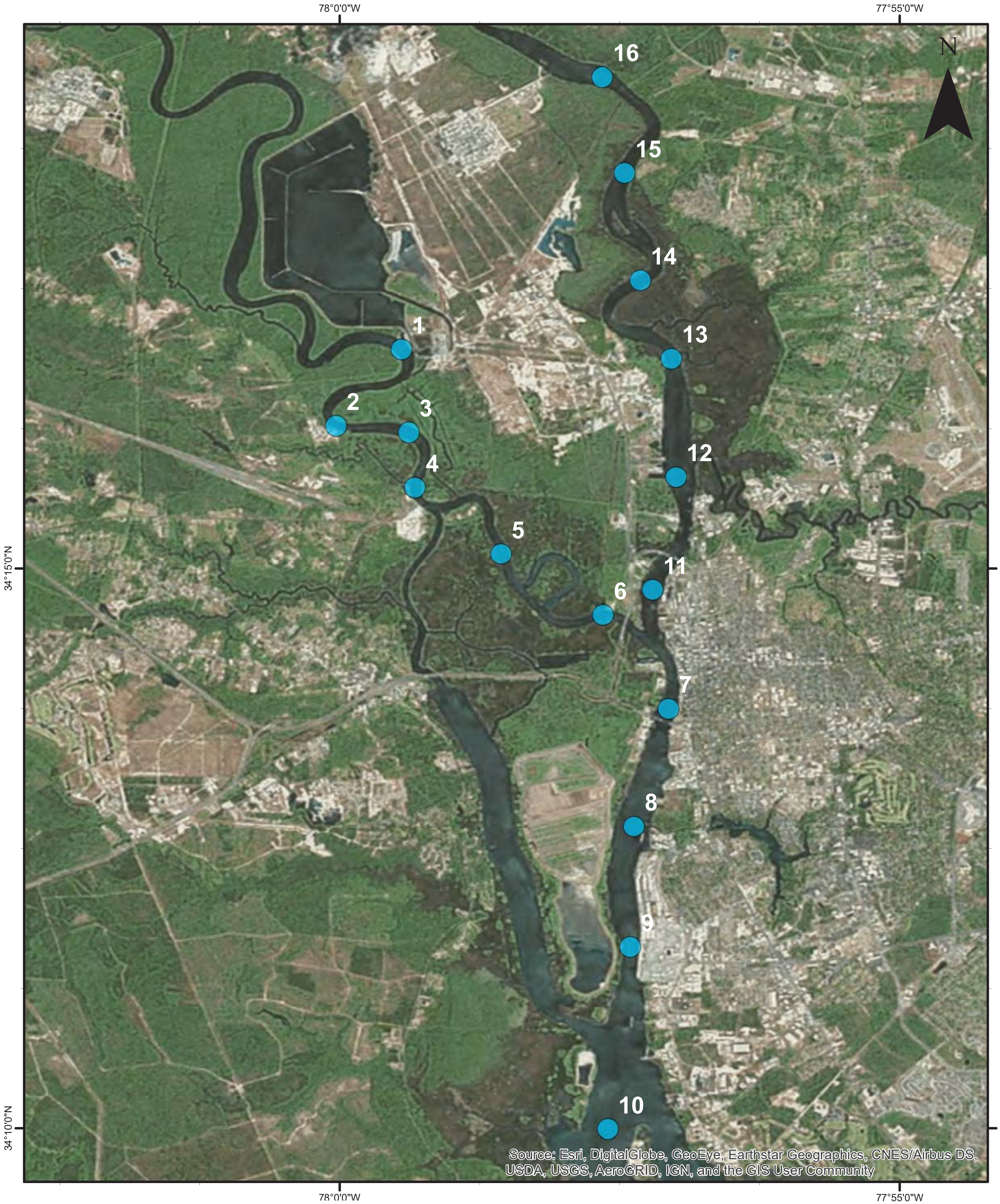


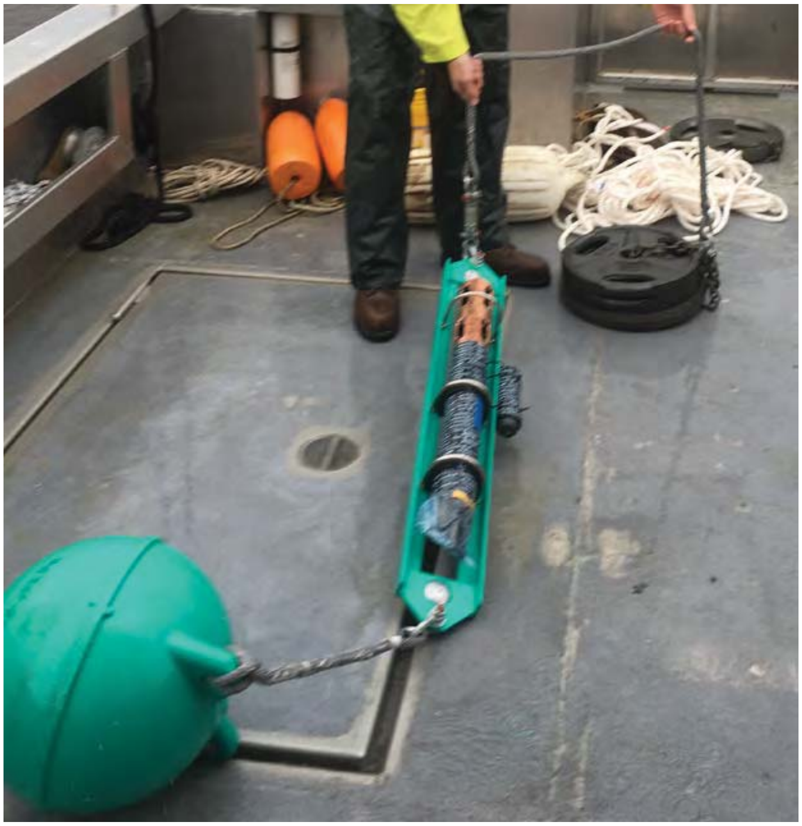
Figure 7
Cape Fear Water Quality
Locations of the CTD Cast Along Channel Center Line
August 10, 2017

PHOTOGRAPHS

Photograph 1: Antifouling measures applied to EXO sonde

Photograph 2: Bottom frame deployed at ADM

Photograph 3: Bottom frame deployed at UBI

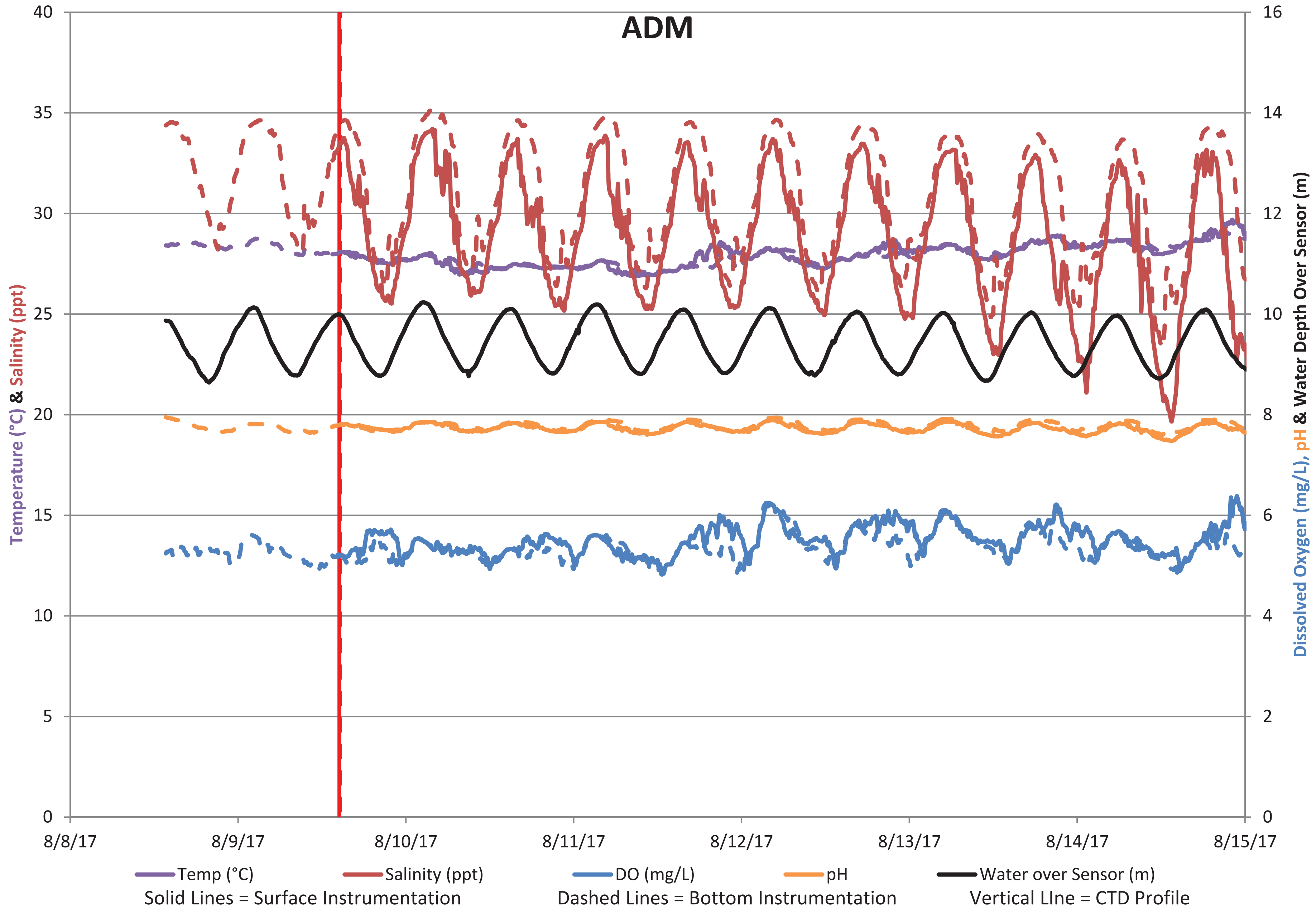


Photograph 4: Mooring for bottom sensor at KM

Photograph 5: Recovery of mooring at KM

Photograph 6: Biofouling on sonde at UBI

APPENDIX I Plots of Results of Long-term Water Quality Measurements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Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
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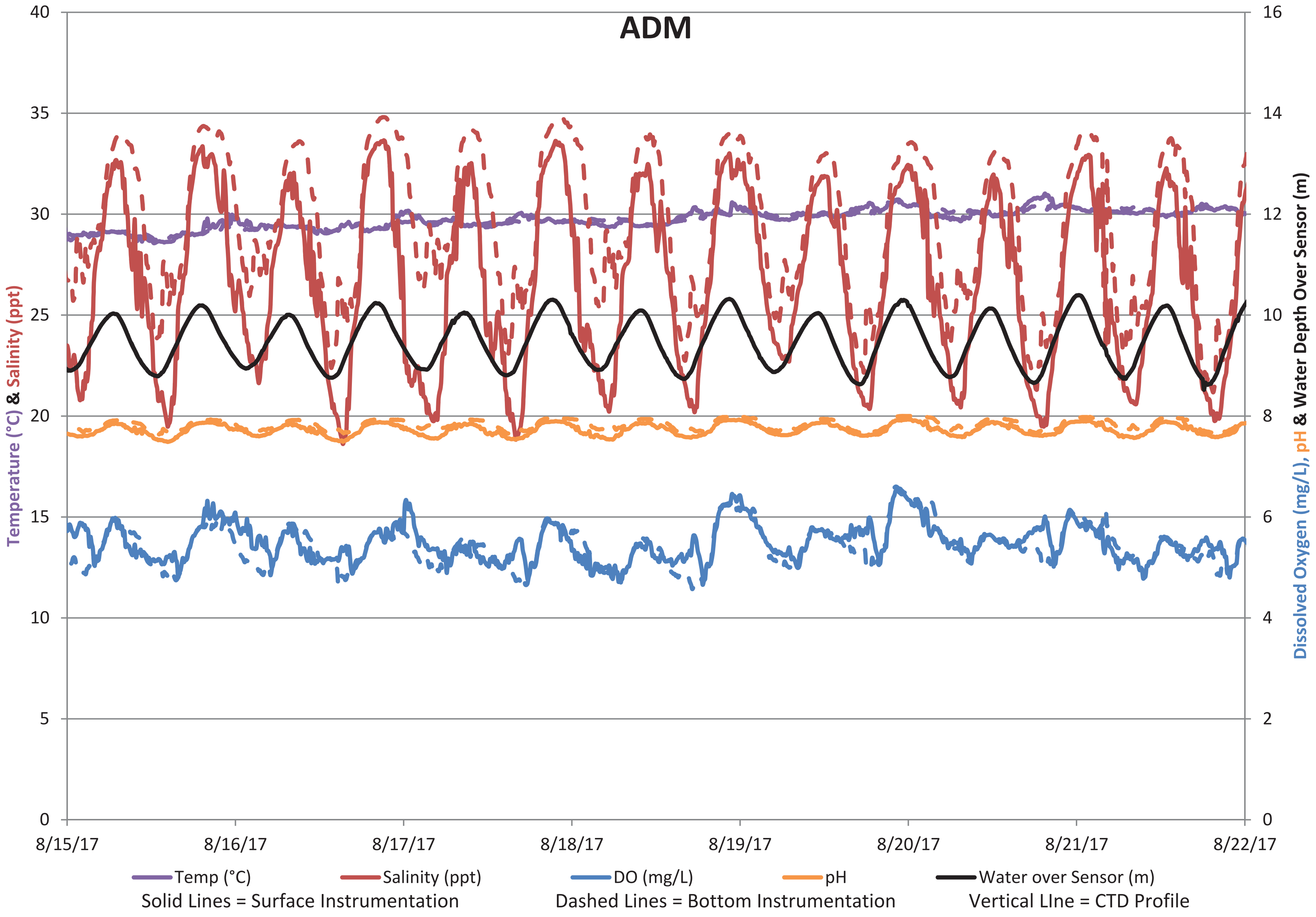
8/13/17
8/14/17
8/15/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


ADM
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
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8/15/17
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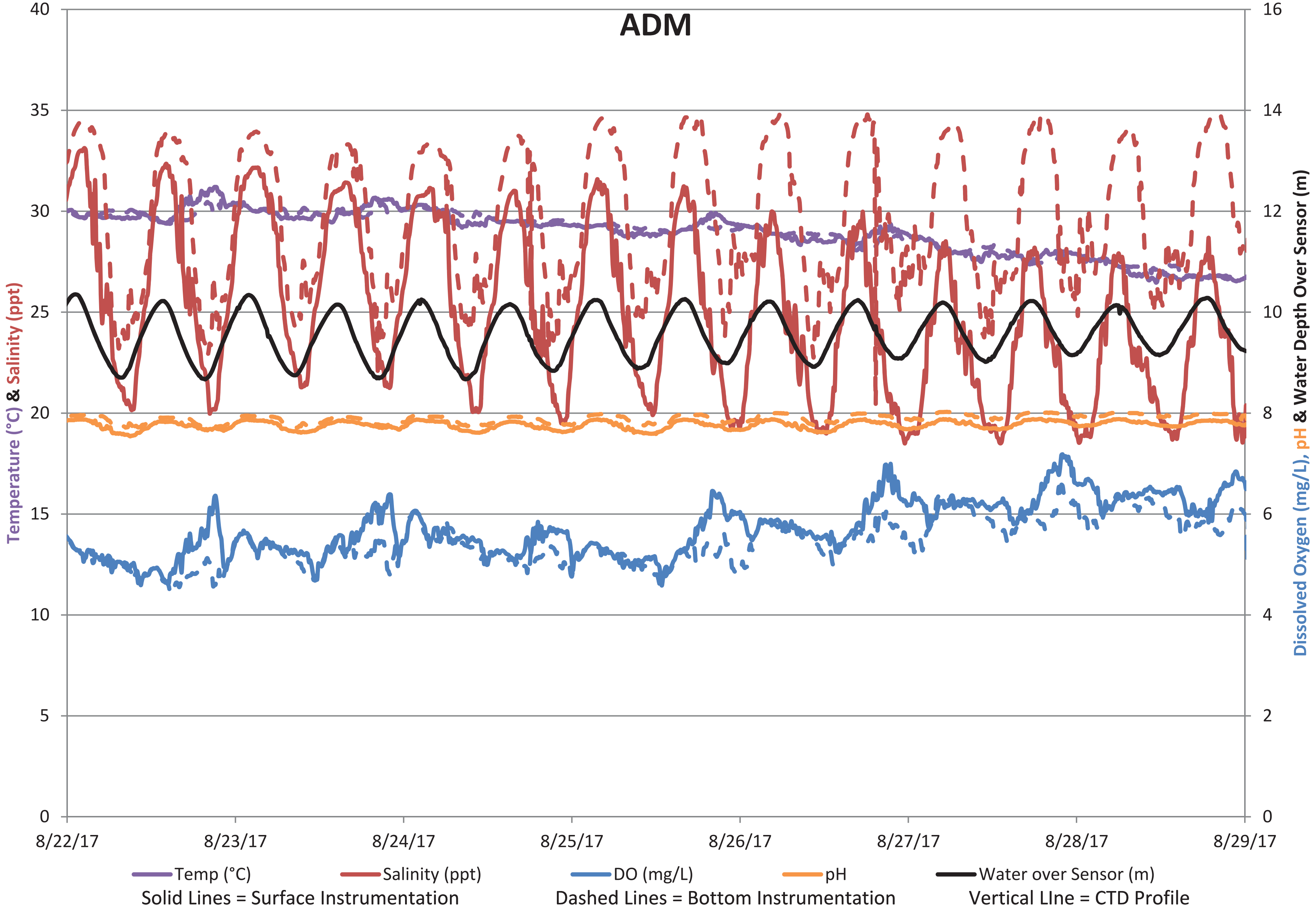
8/21/17
8/22/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


ADM
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Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
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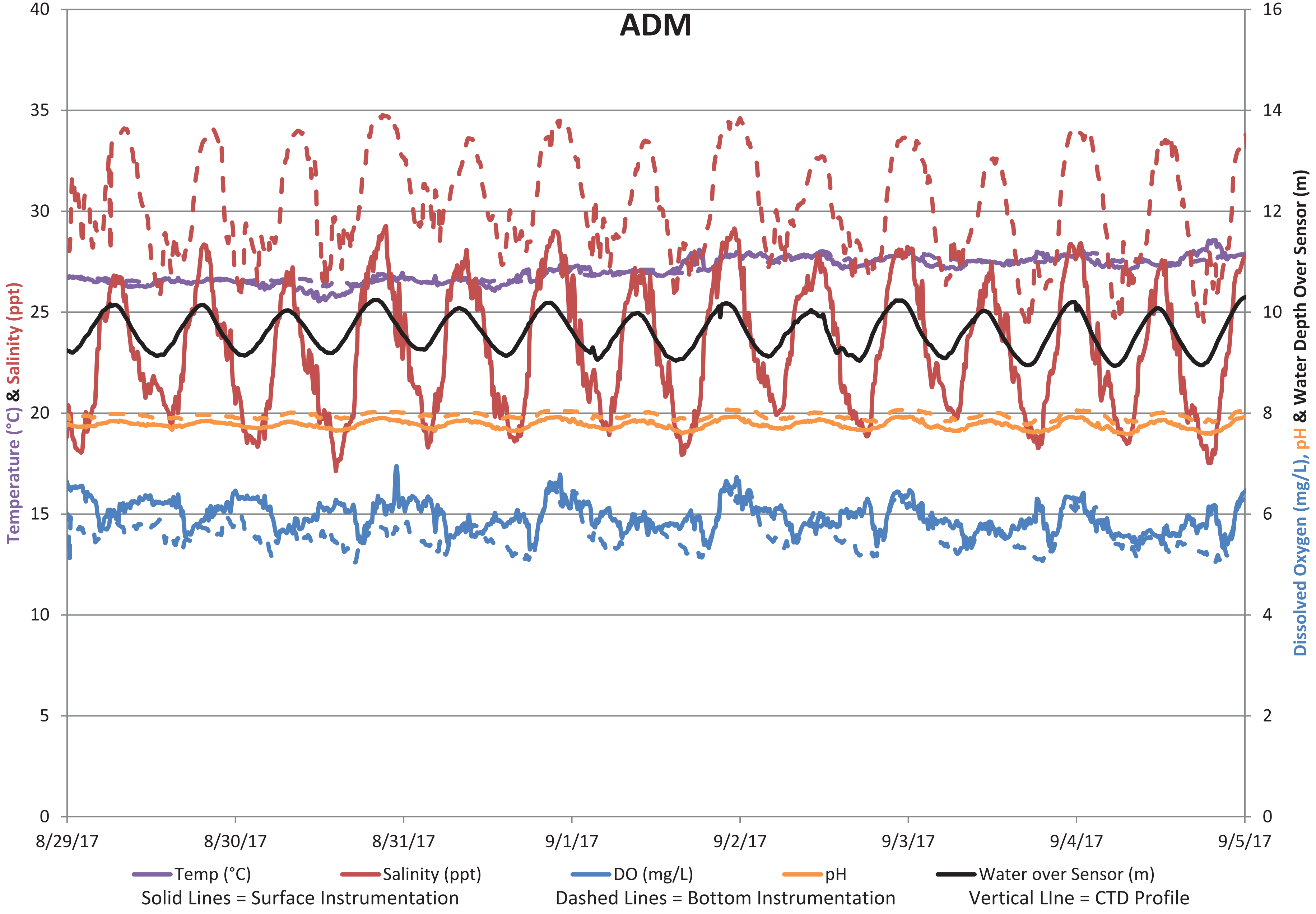
8/29/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


ADM
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Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
8/29/17
8/30/17
8/31/17
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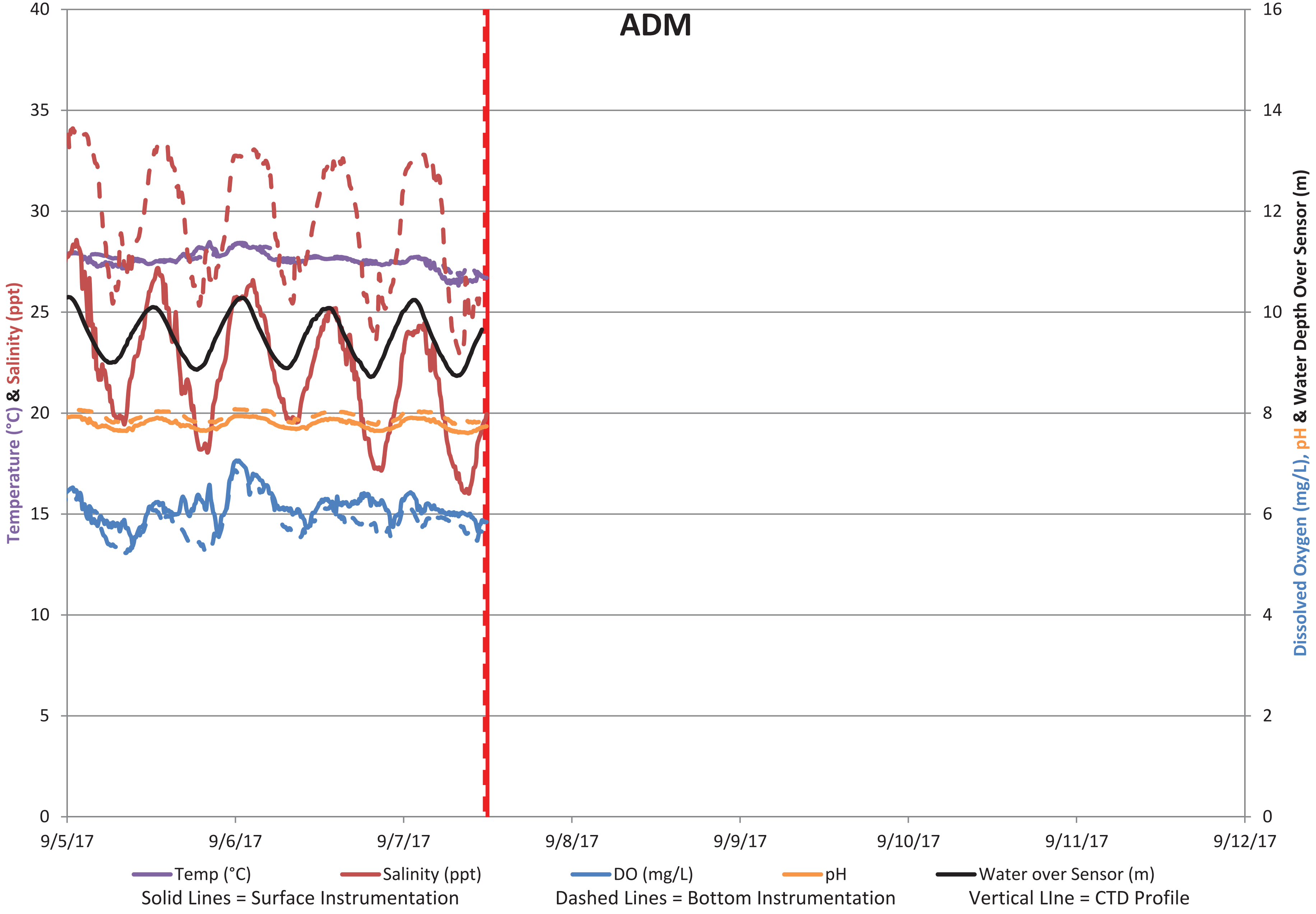
9/3/17
9/4/17
9/5/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile

ADM
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
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16
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2
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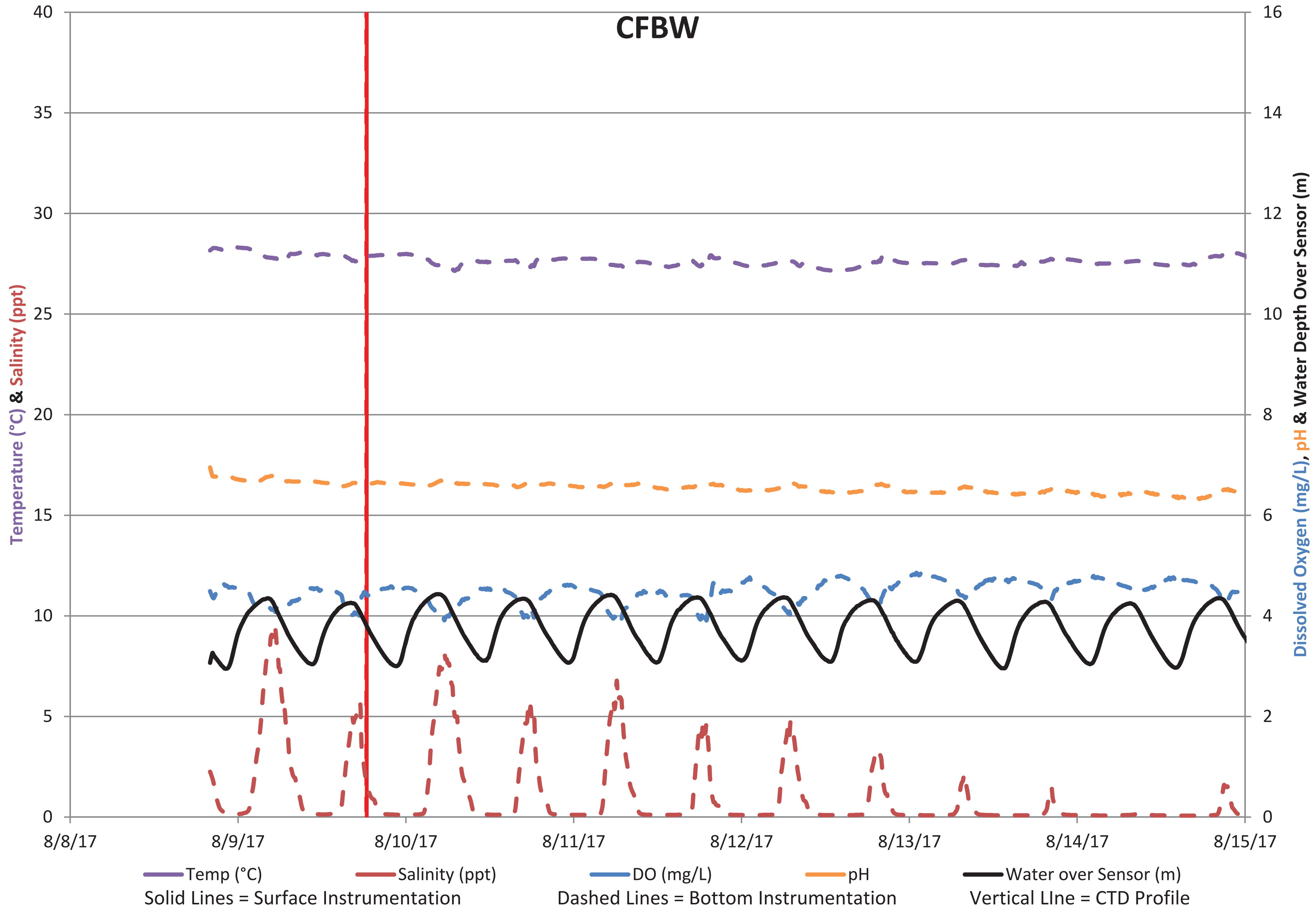
9/5/17
9/6/17
9/7/17
9/8/17
9/9/17
9/10/17
9/11/17
9/12/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


CFBW
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
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30
25
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15
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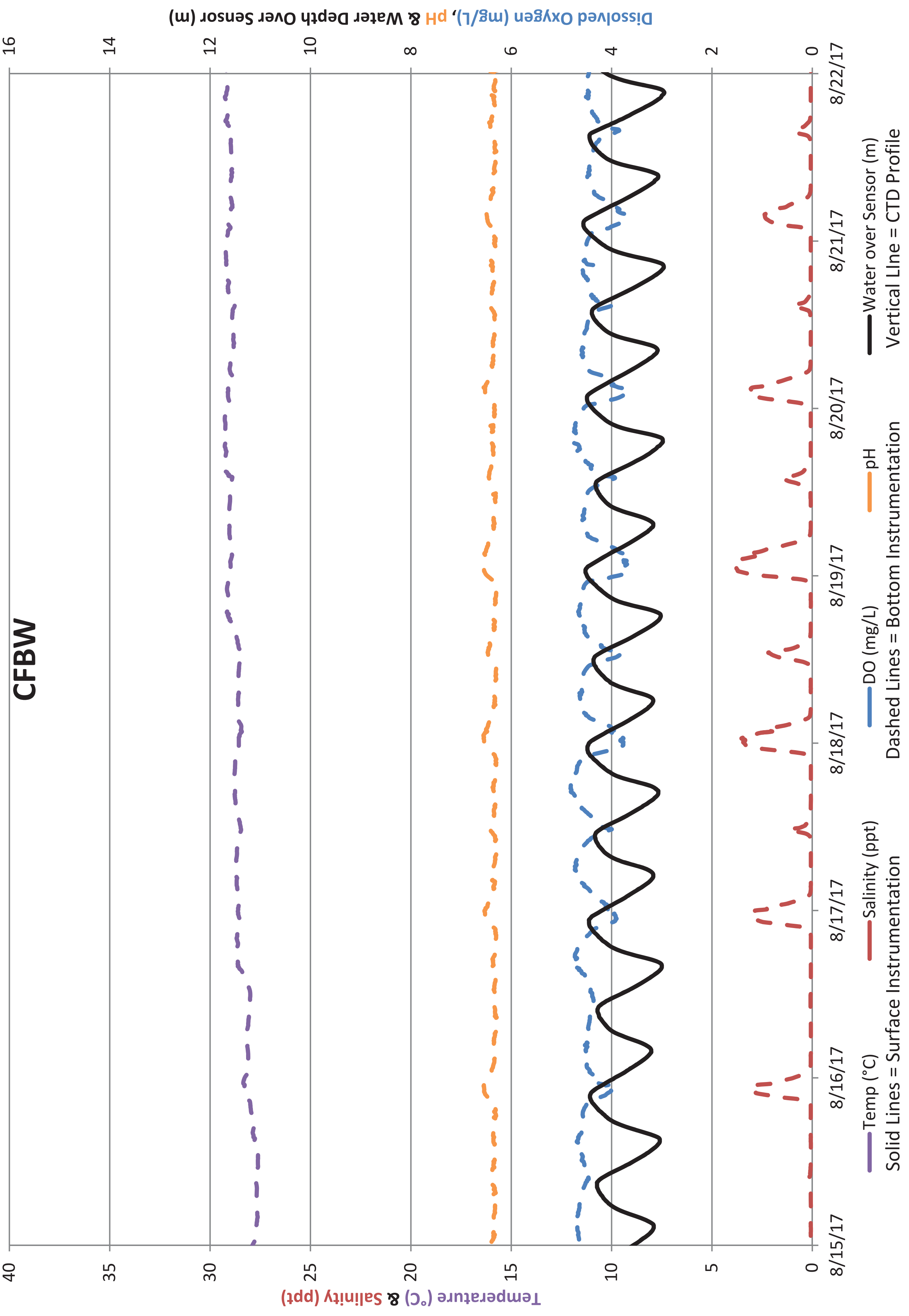
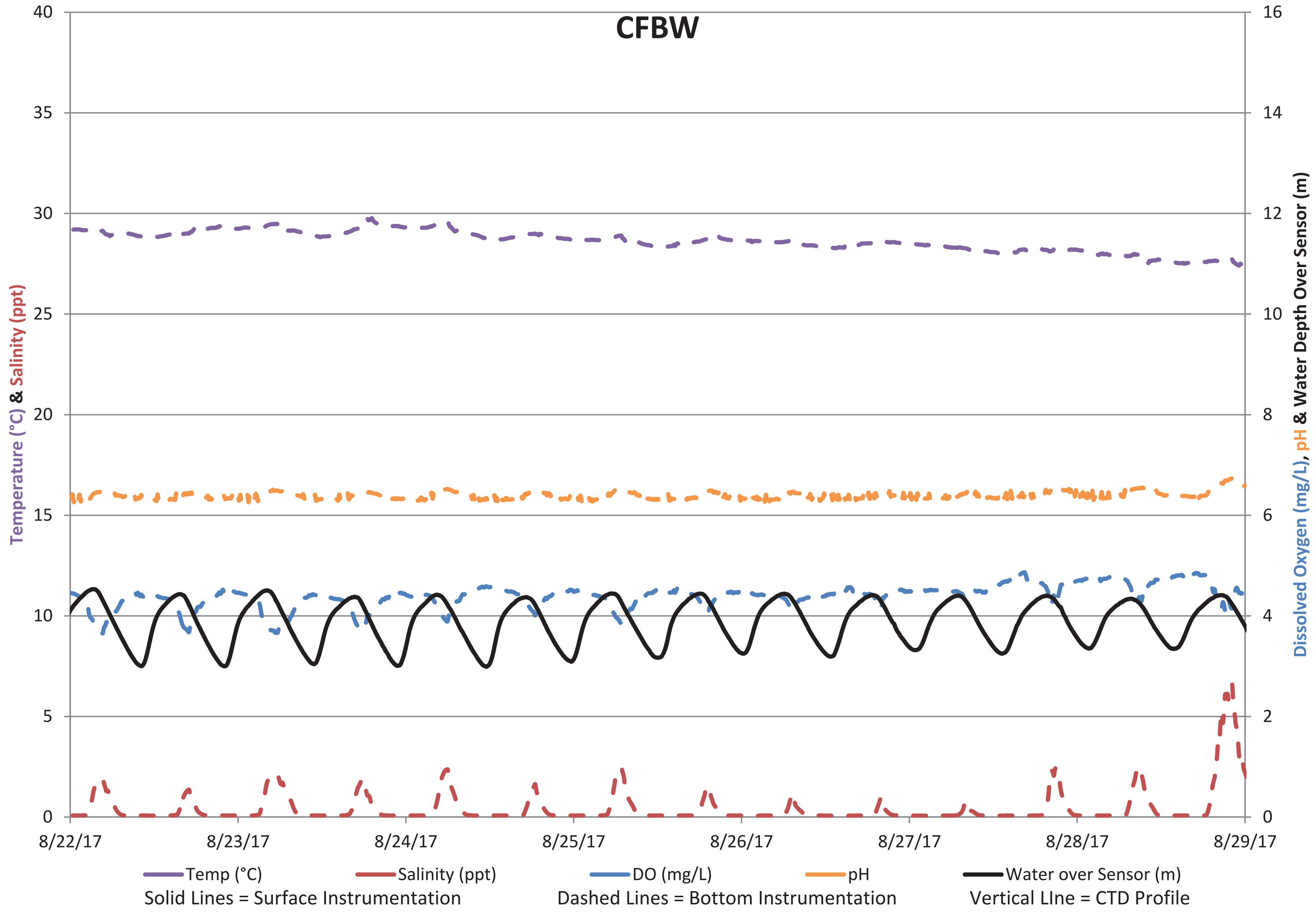
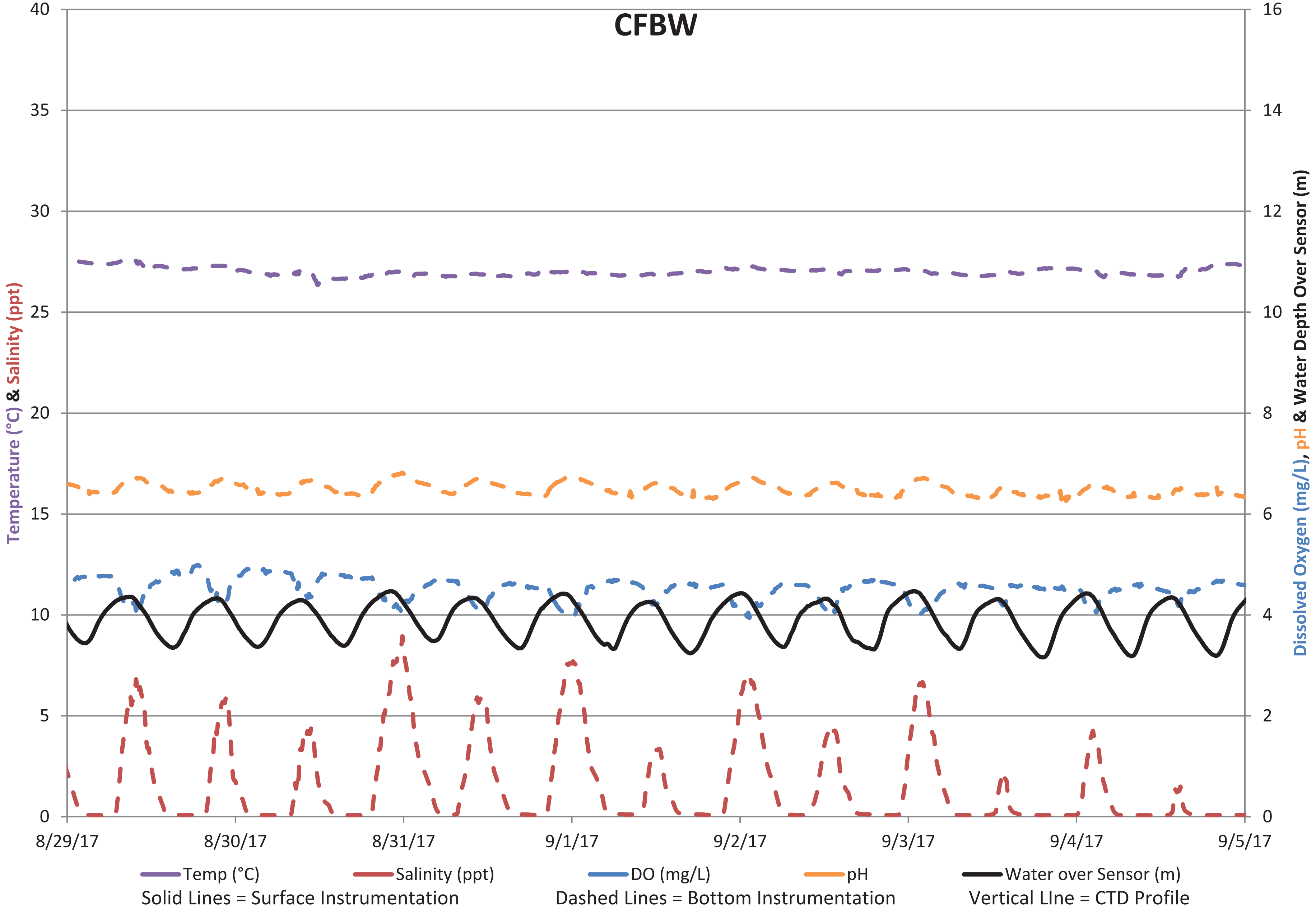
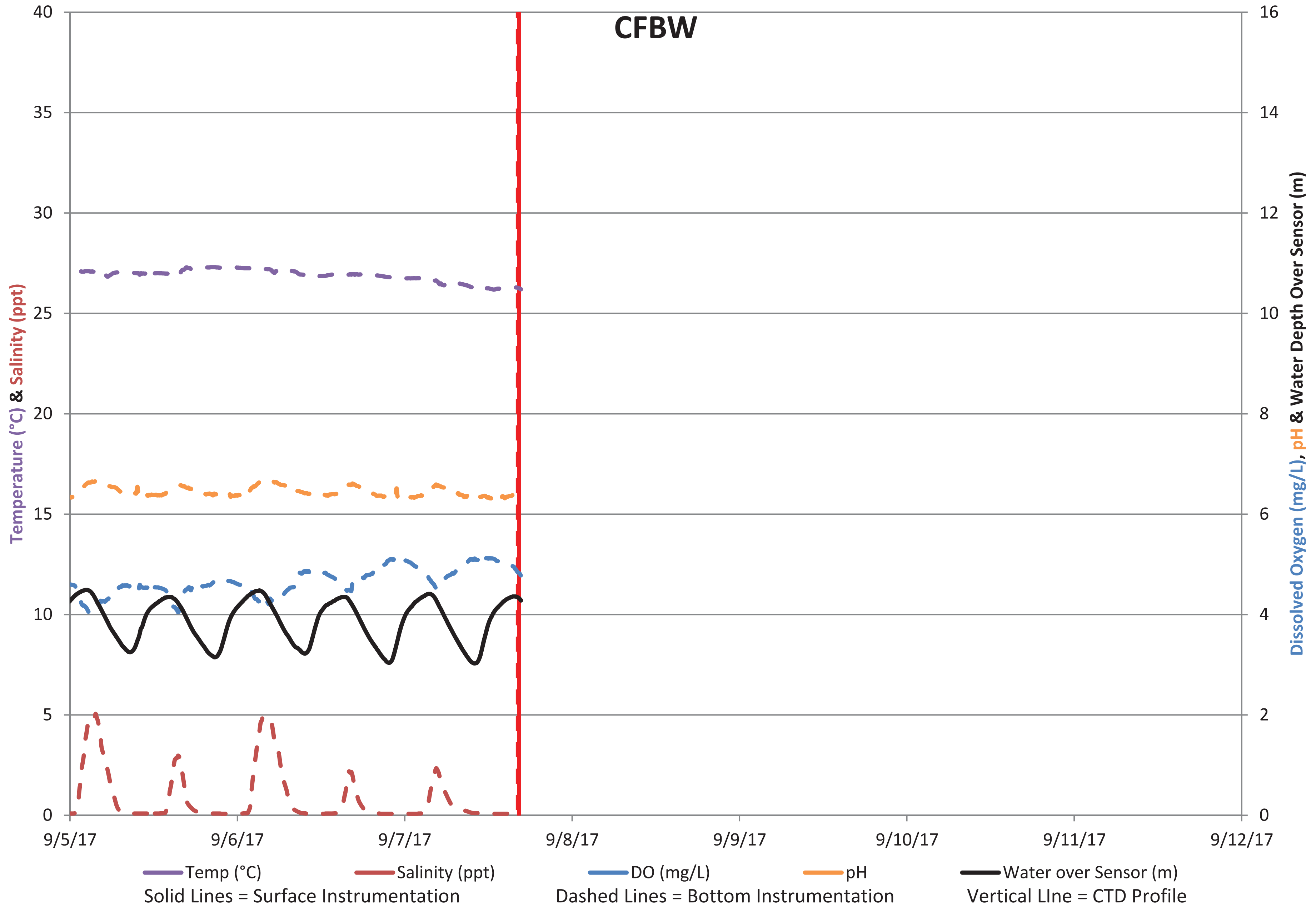
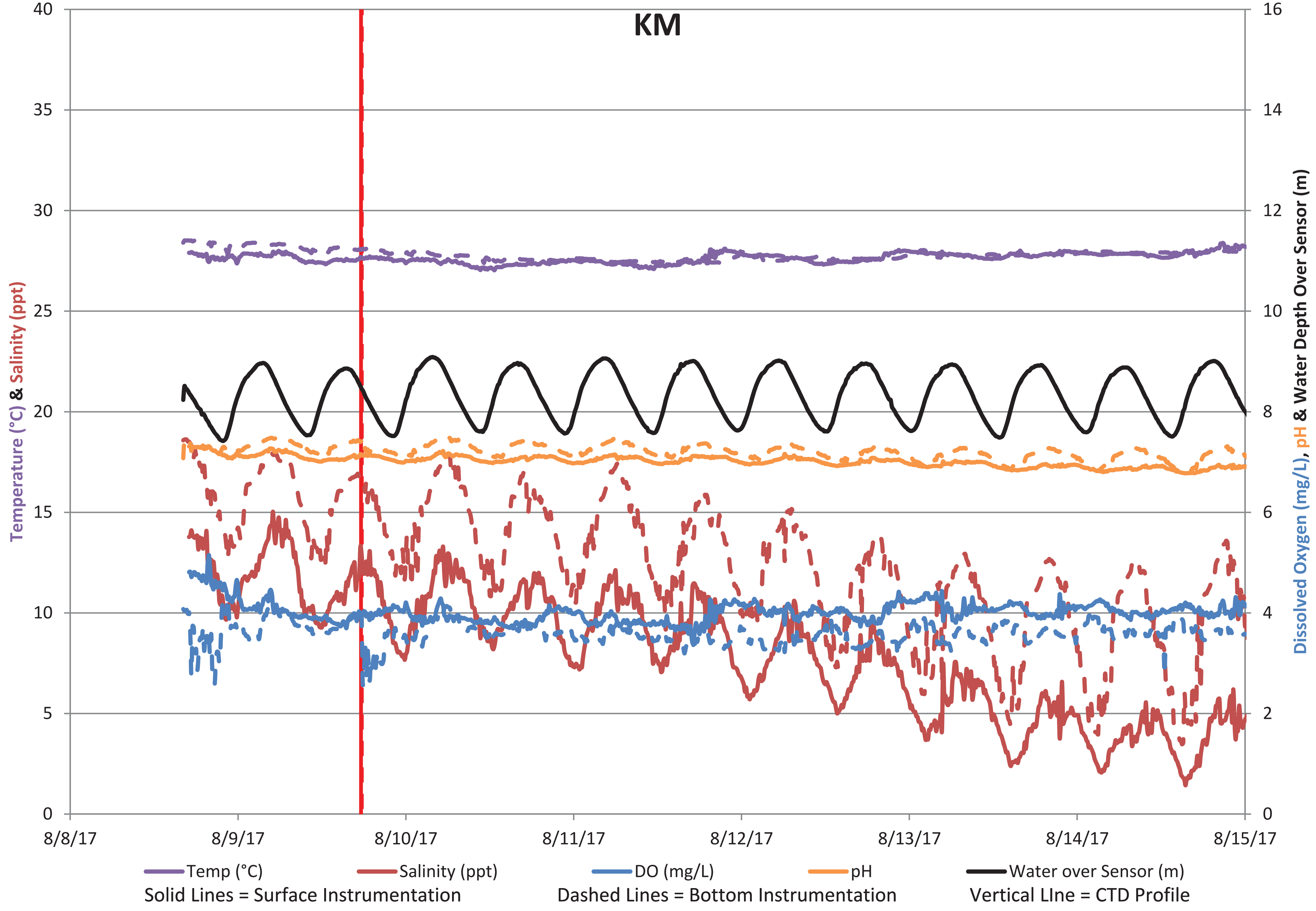
5
0
16
14
12
10
8
6
4
2
0
8/8/17
8/9/17
8/10/17
8/11/17
8/12/17
8/13/17
8/14/17
8/15/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile

CFBW
Temperature (°C) & Salinity (ppt)
0
5
10
15
20
25
30
35
40
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
0
2
4
6
8
10
12
14
16
8/15/17
8/16/17
8/17/17
8/18/17
8/19/17
8/20/17
8/21/17
8/22/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical Line = CTD Profile


CFBW
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
35
30
25
20
15
10
5
0
16
14
12
10
8
6
4
2
0
8/22/17
8/23/17
8/24/17
8/25/17
8/26/17
8/27/17
8/28/17
8/29/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile

CFBW
Temperature (°C) & Salinity (ppt)
40
35
30
25
20
15
10
5
0
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
16
14
12
10
8
6
4
2
0
8/29/17
8/30/17
8/31/17
9/1/17
9/2/17
9/3/17
9/4/17
9/5/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


CFBW
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
35
30
25
20
15
10
5
0
16
14
12
10
8
6
4
2
0
9/5/17
9/6/17
9/7/17
9/8/17
9/9/17
9/10/17
9/11/17
9/12/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


KM
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
35
30
25
20
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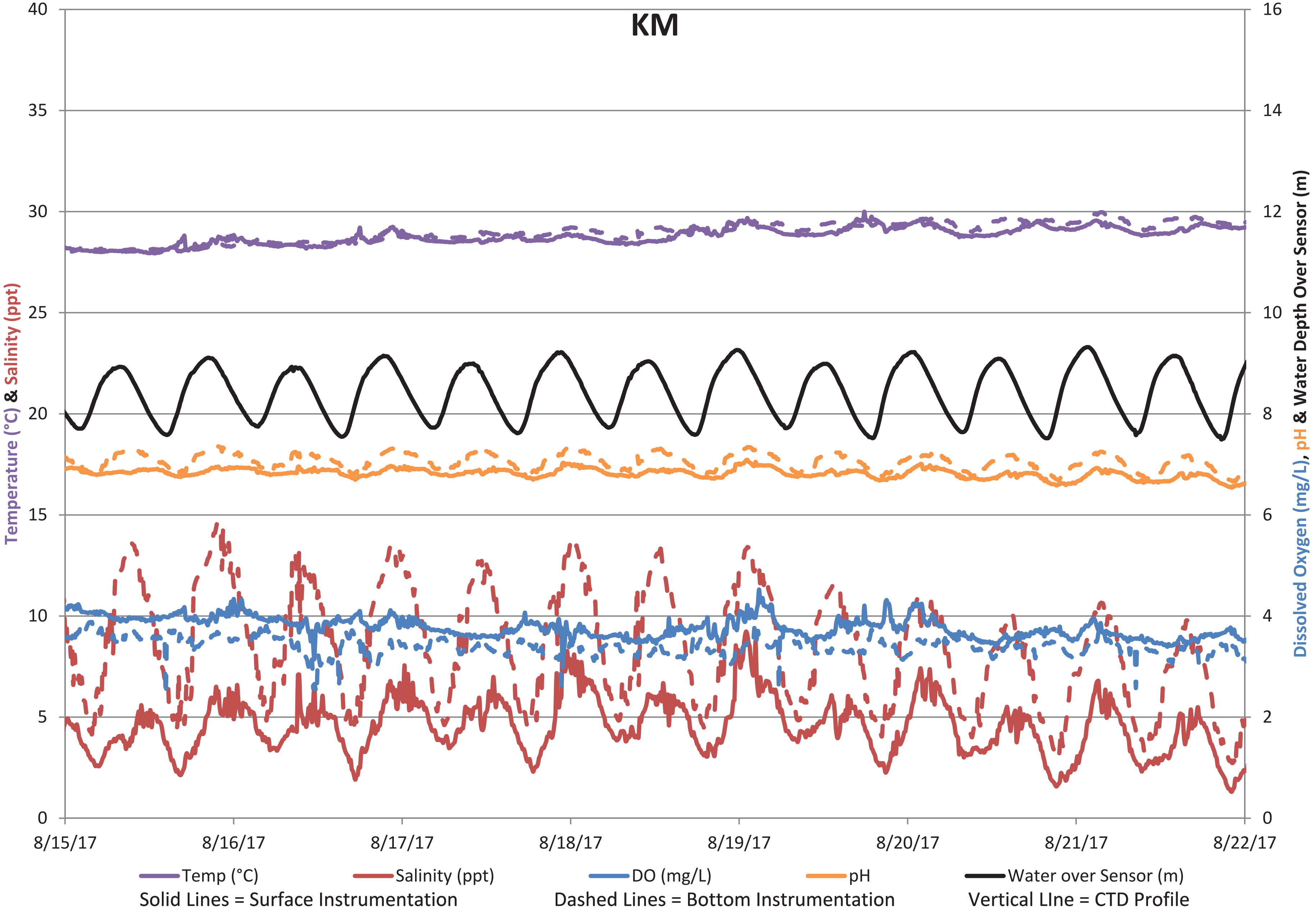
10
5
0
16
14
12
10
8
6
4
2
0
8/8/17
8/9/17
8/10/17
8/11/17
8/12/17
8/13/17
8/14/17
8/15/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


KM
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
35
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25
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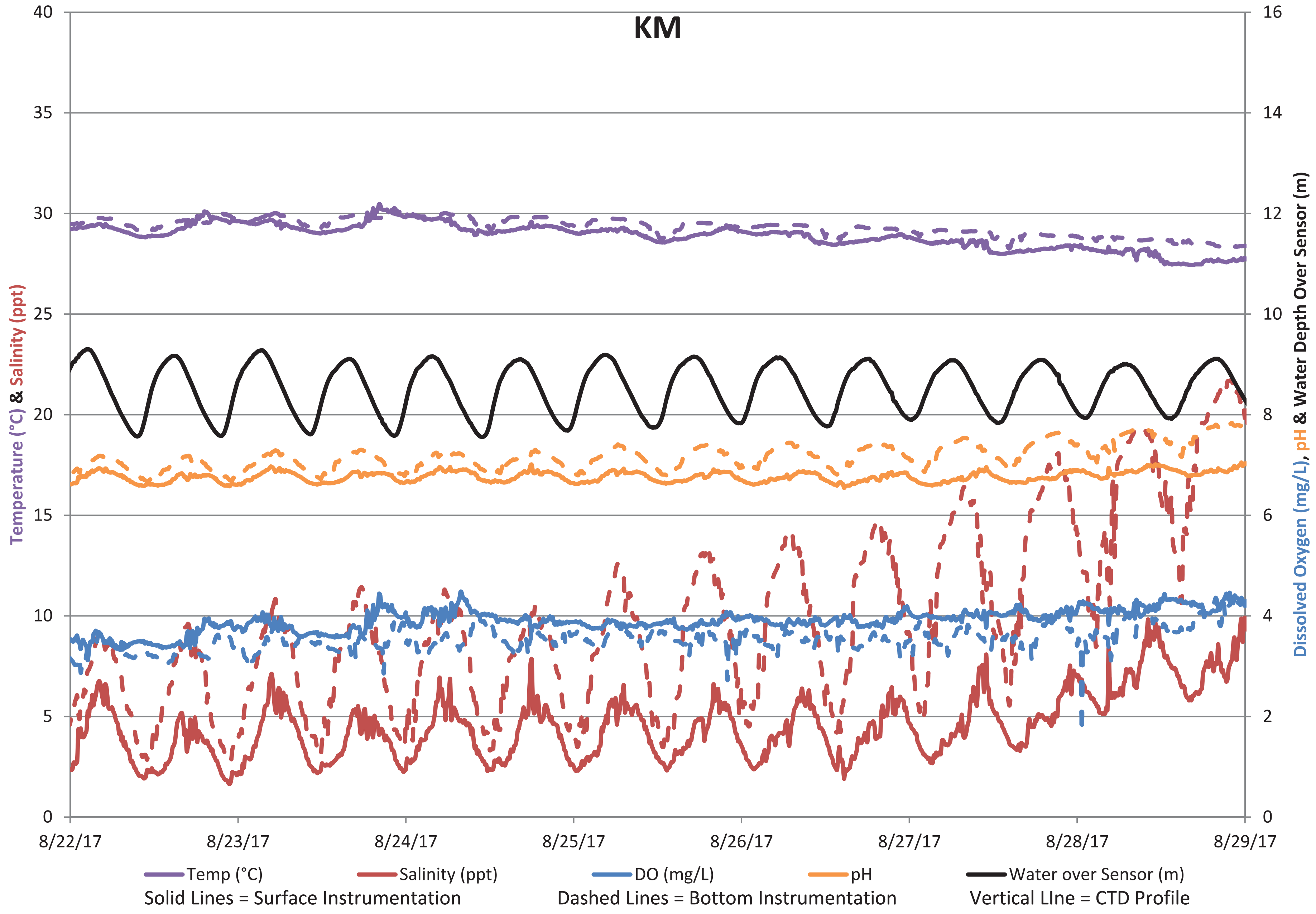
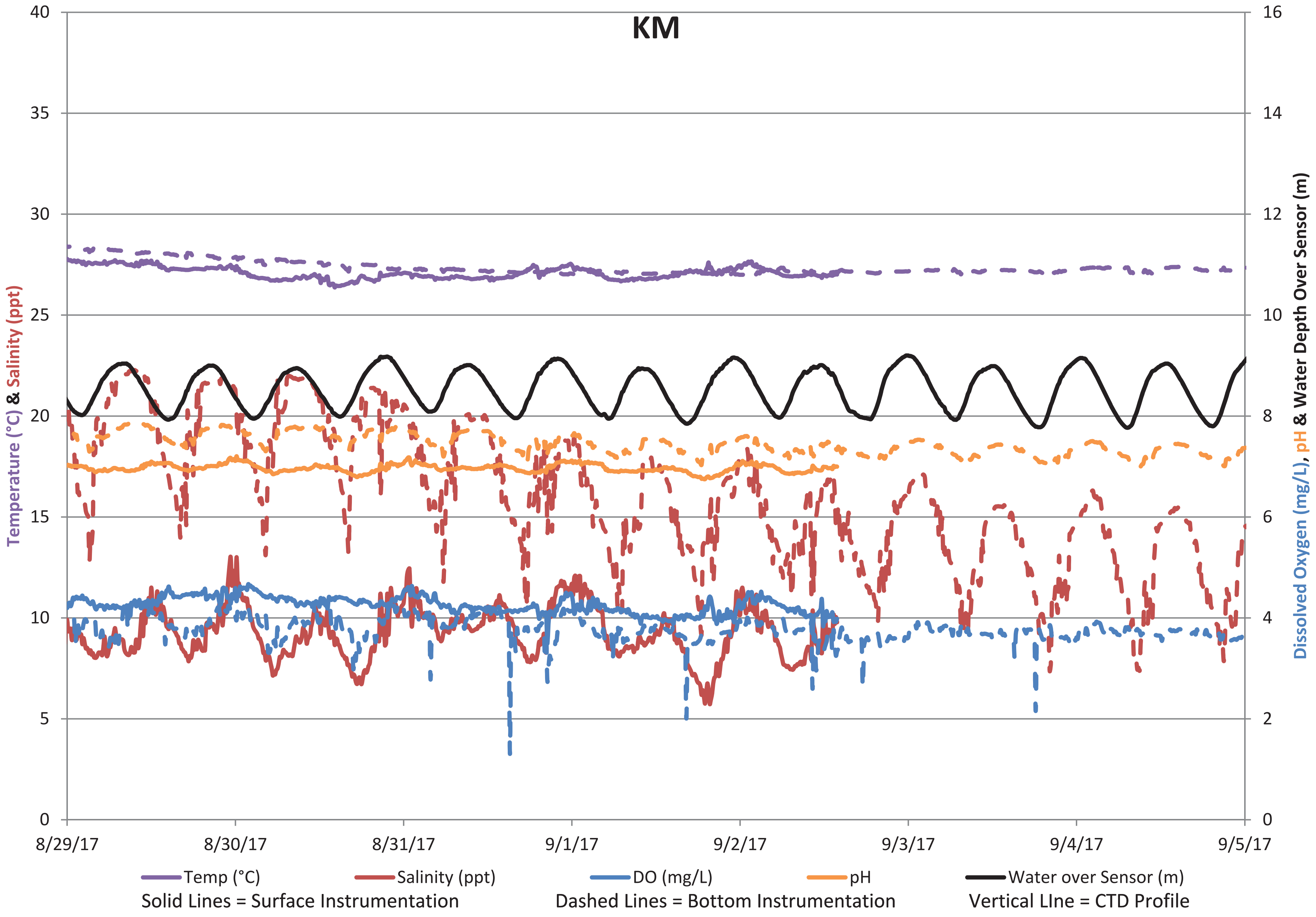
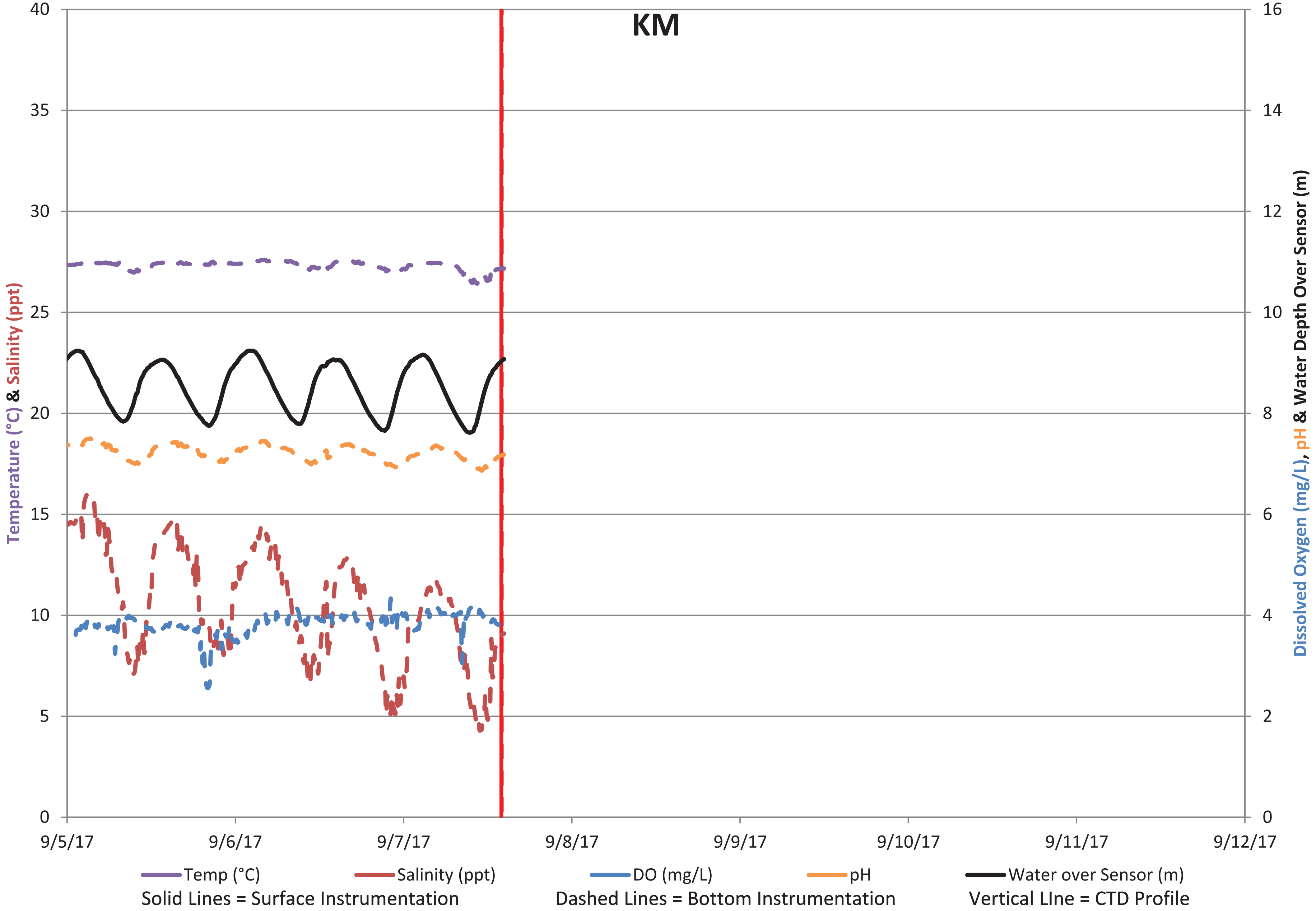
15
10
5
0
16
14
12
10
8
6
4
2
0
8/15/17
8/16/17
8/17/17
8/18/17
8/19/17
8/20/17
8/21/17
8/22/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


KM
40
35
30
25
20
15
10
5
0
Temperature (°C) & Salinity (ppt)
16
14
12
10
8
6
4
2
0
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
8/22/17
8/23/17
8/24/17
8/25/17
8/26/17
8/27/17
8/28/17
8/29/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


KM
40
35
30
25
20
15
10
5
0
16
14
12
10
8
6
4
2
0
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
8/29/17
8/30/17
8/31/17
9/1/17
9/2/17
9/3/17
9/4/17
9/5/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


KM
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
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9/5/17
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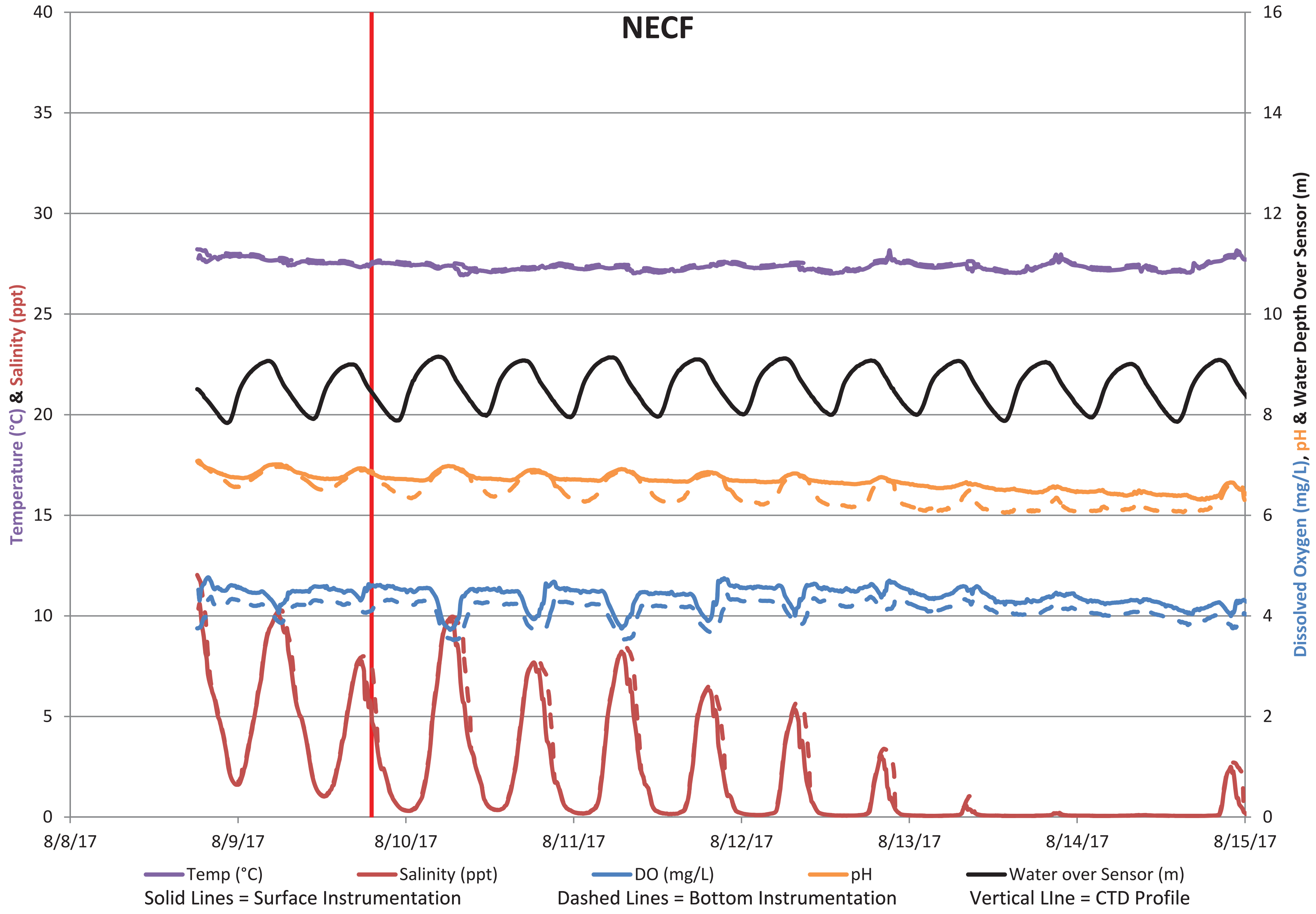
9/7/17
9/8/17
9/9/17
9/10/17
9/11/17
9/12/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


NECF
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
35
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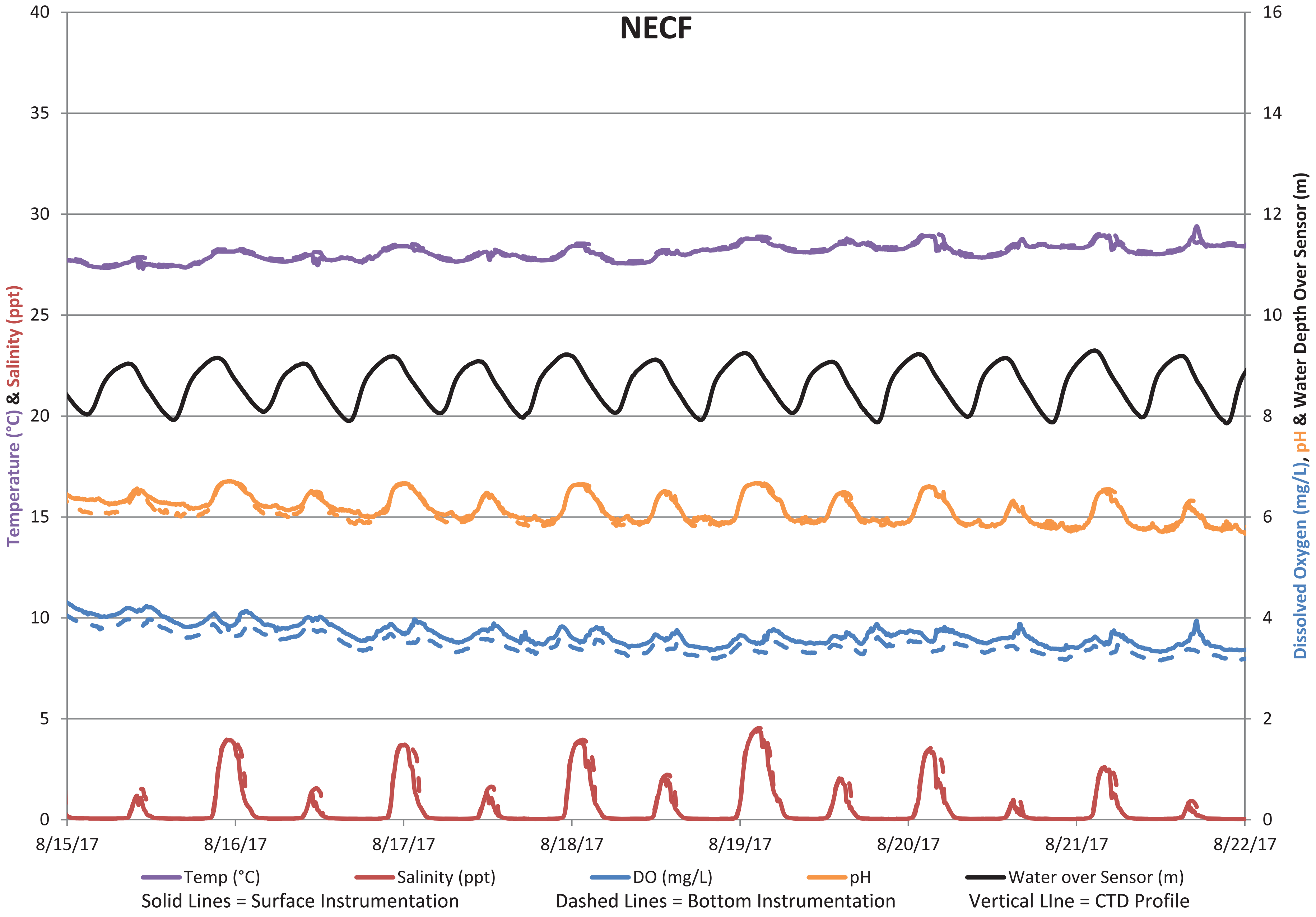
8/13/17
8/14/17
8/15/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


NECF
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
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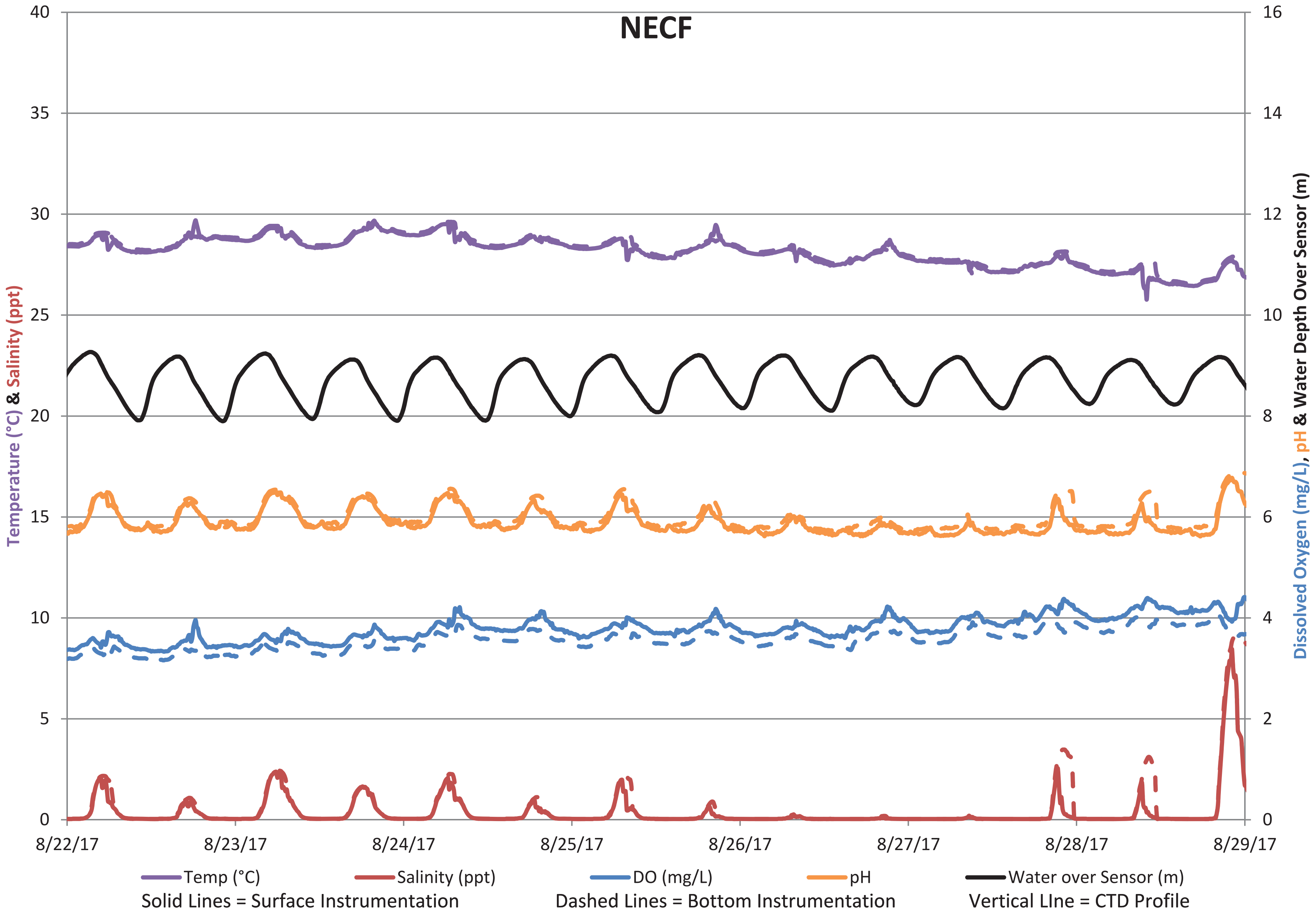
8/17/17
8/18/17
8/19/17
8/20/17
8/21/17
8/22/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


NECF
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
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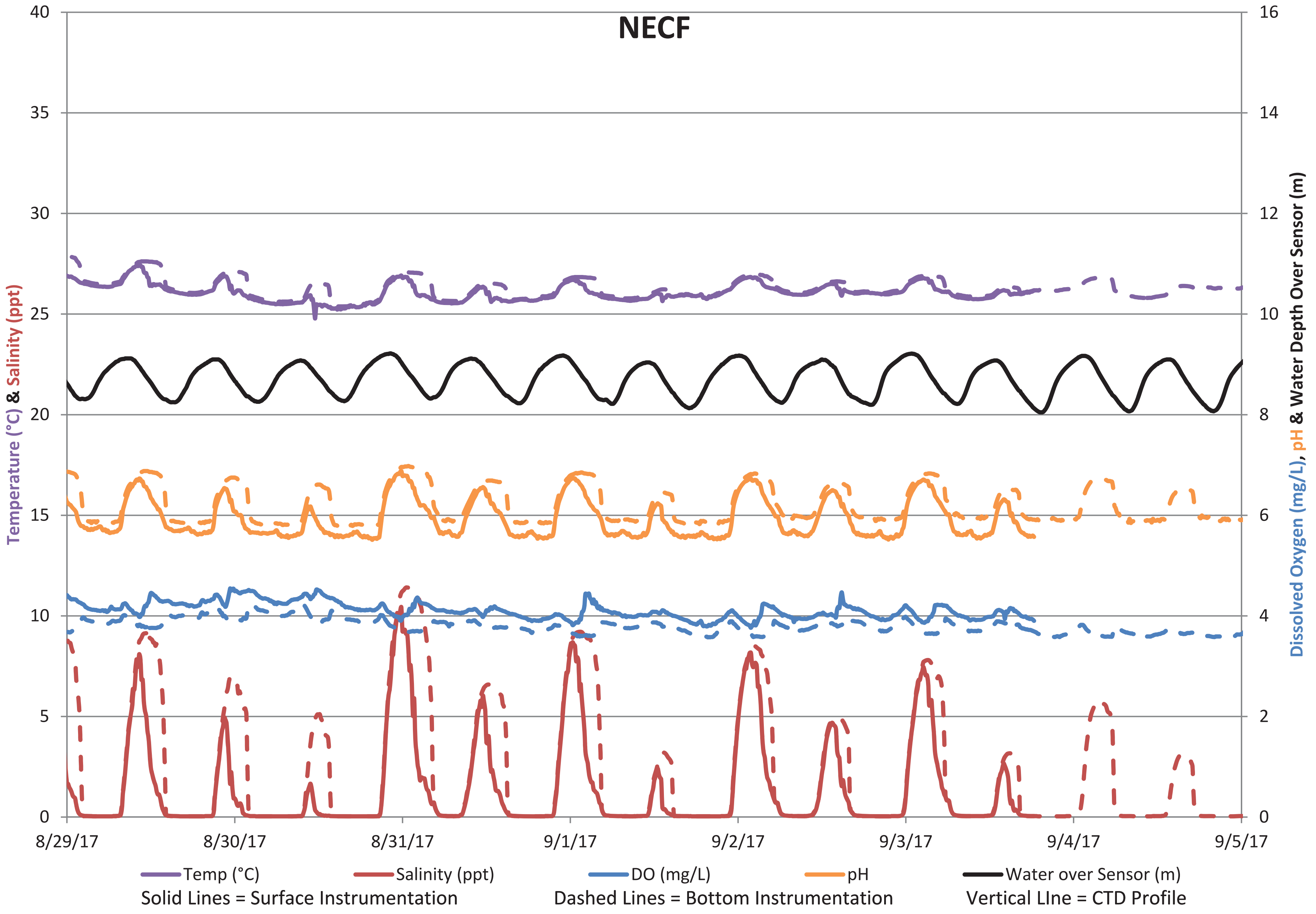
8/22/17
8/23/17
8/24/17
8/25/17
8/26/17
8/27/17
8/28/17
8/29/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


NECF
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5
0
Temperature (°C) & Salinity (ppt)
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8
6
4
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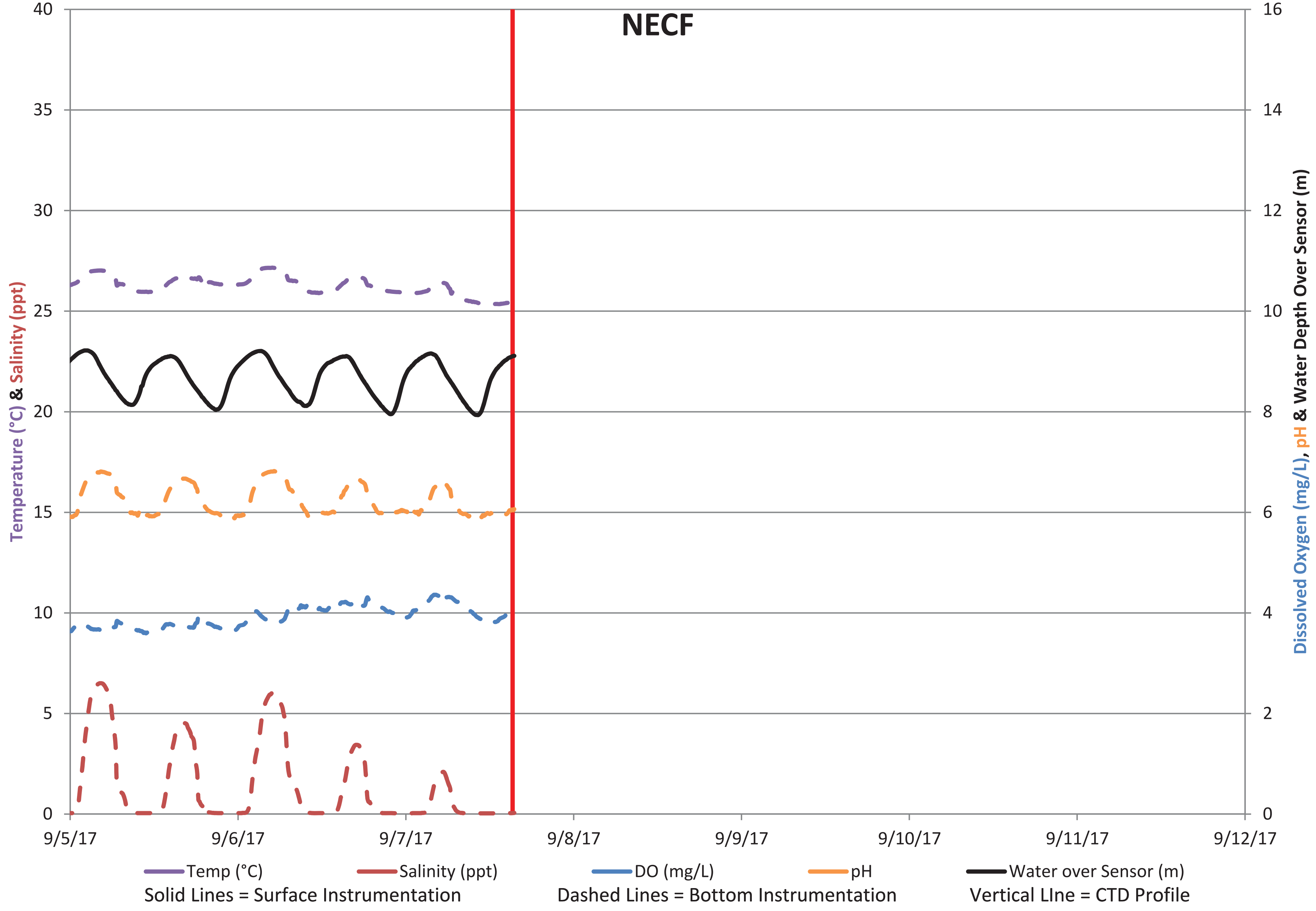
0
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
8/29/17
8/30/17
8/31/17
9/1/17
9/2/17
9/3/17
9/4/17
9/5/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


NECF
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
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9/5/17
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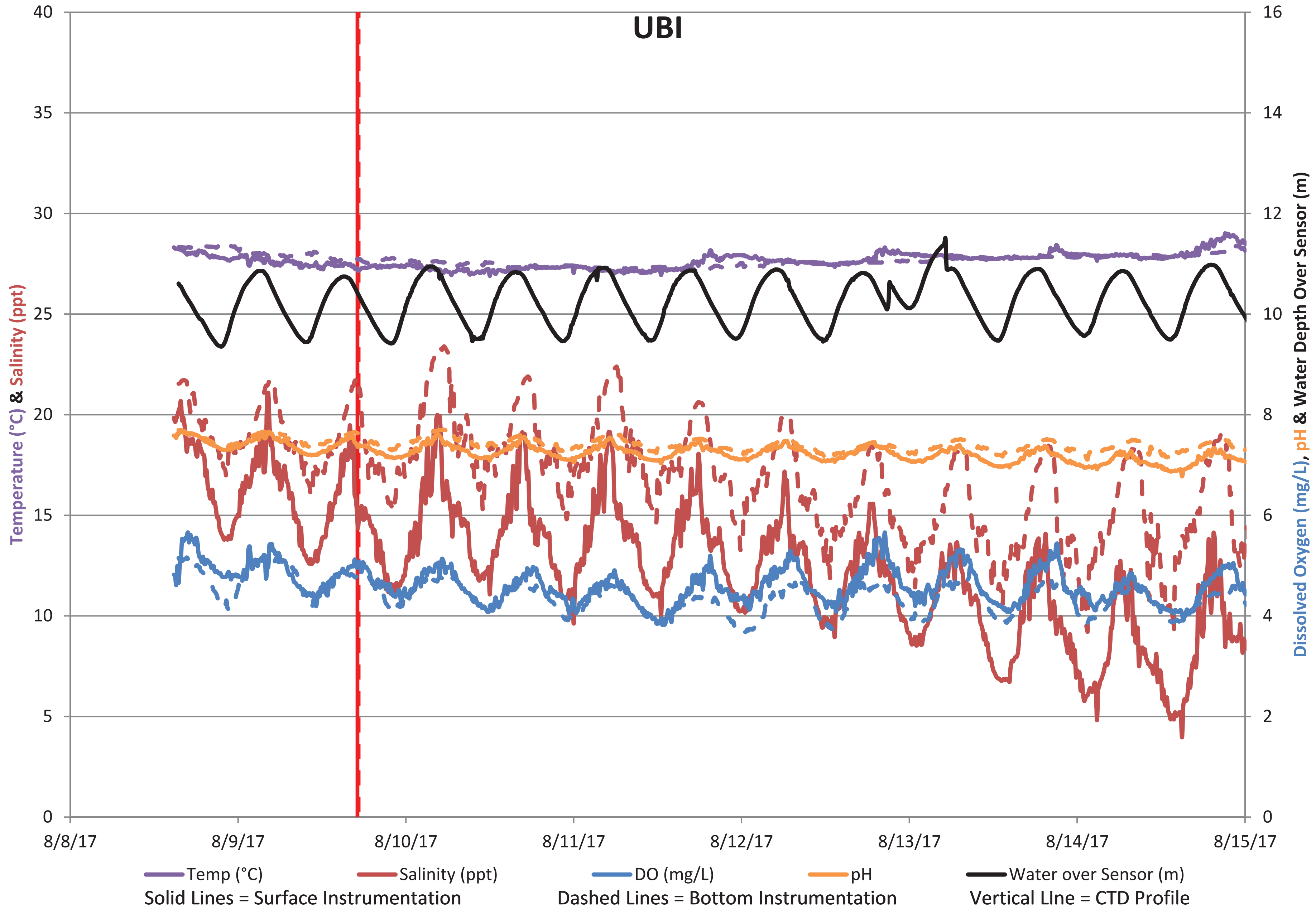
9/8/17
9/9/17
9/10/17
9/11/17
9/12/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


UBI
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35
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25
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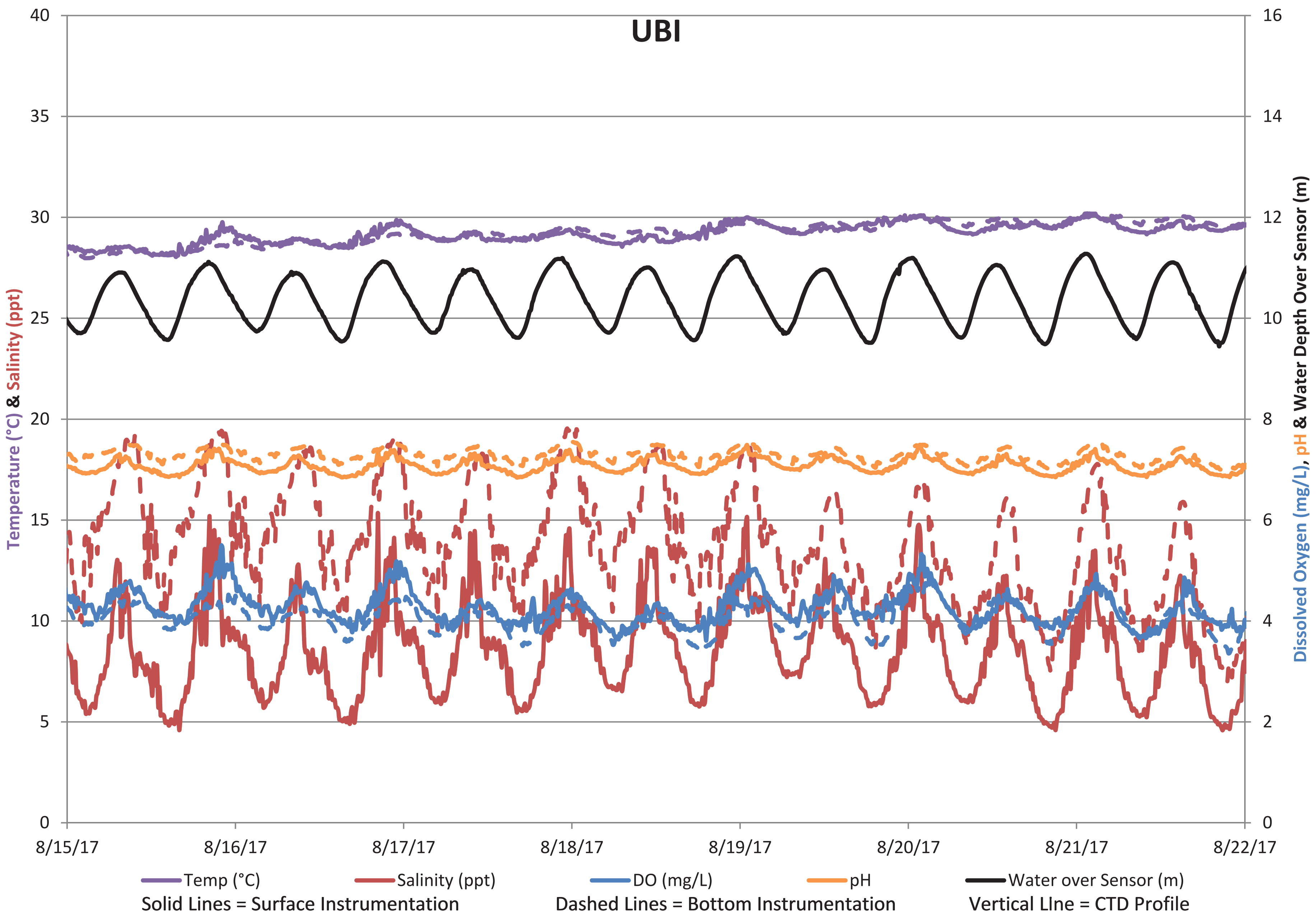
4
2
0
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
8/8/17
8/9/17
8/10/17
8/11/17
8/12/17
8/13/17
8/14/17
8/15/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


UBI
Temperature (°C) & Salinity (ppt)
40
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30
25
20
15
10
5
0
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
16
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8/15/17
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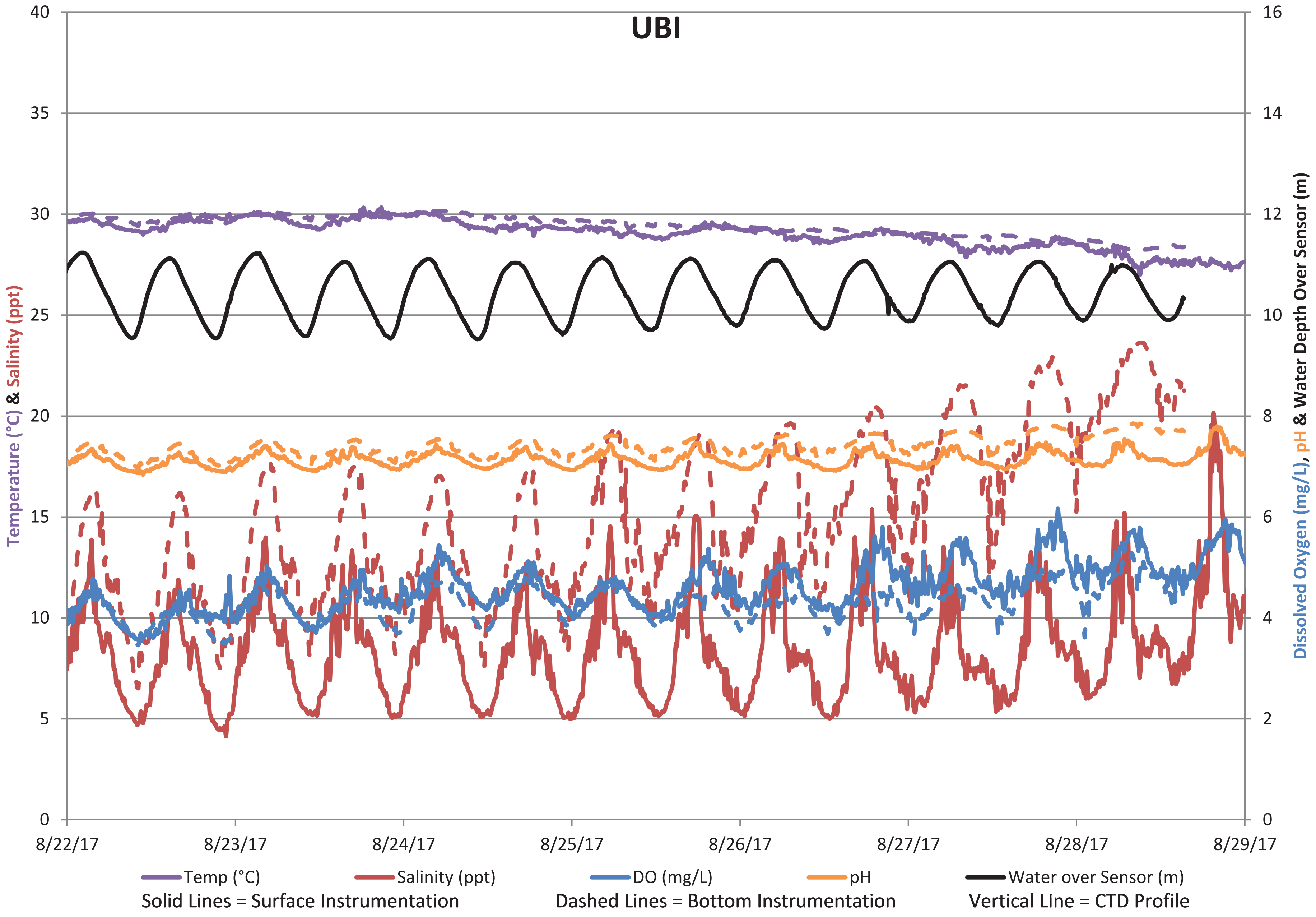
8/17/17
8/18/17
8/19/17
8/20/17
8/21/17
8/22/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


UBI
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
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16
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12
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8
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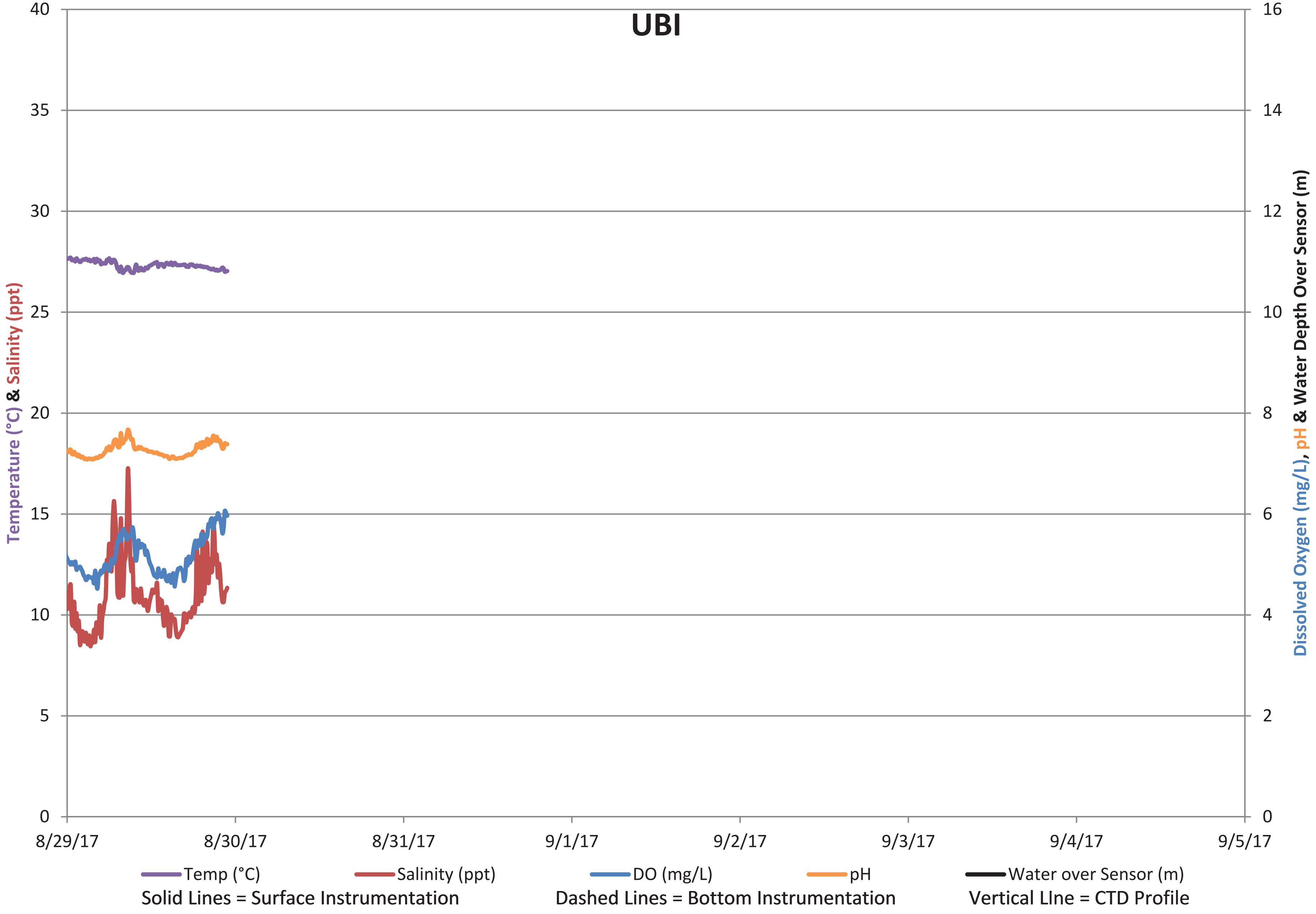
8/22/17
8/23/17
8/24/17
8/25/17
8/26/17
8/27/17
8/28/17
8/29/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile


UBI
Temperature (°C) & Salinity (ppt)
Dissolved Oxygen (mg/L), pH & Water Depth Over Sensor (m)
40
35
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25
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15
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16
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4
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0
8/29/17
8/30/17
8/31/17
9/1/17
9/2/17
9/3/17
9/4/17
9/5/17
Temp (°C)
Salinity (ppt)
DO (mg/L)
pH
Water over Sensor (m)
Solid Lines = Surface Instrumentation
Dashed Lines = Bottom Instrumentation
Vertical LIne = CTD Profile

APPENDIX II Certificates of Analysis for Water Samples

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 − (843) 556−8171 − www.gel.com

Certificate of Analysis Report
for

EVHI001 RPS Evans Hamilton

Client SDG: 430306 GEL Work Order: 430306

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria
** Analyte is a Tracer compound
** Analyte is a surrogate compound
J Value is estimated
U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
d 5−day BOD−−The 2:1 depletion requirement was not met for this sample
e 5−day BOD−−Test replicates show more than 30% difference between high and low values. The data is qualified per the method and can be used for reporting purposes

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Jake Crook.

Jacob H Crook

Reviewed by ______________________________

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	ADM-S-PO4	Project:	EVHI03017
Sample ID:	430306001	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 10:12		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.772	0.033	0.100	mg/L	1.00	1	KLP1	08/24/17	1610	1692768	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite	J	0.0137	0.007	0.020	mg/L		1	AXH3	08/16/17	0950	1690783	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P	U	ND	0.020	0.050	mg/L	1.00	1	KLP1	08/23/17	1040	1692784	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		786	33.0	100	ug/L		1	KLP1	08/24/17	1634	1692013	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	08/23/17	1700	1692765
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	08/22/17	1700	1692782

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID:	ADM-S-BOD		Project:	EVHI03017
Sample ID:	430306002		Client ID:	EVHI001
Matrix:	Water			
Collect Date:	09-AUG-17 10:12			
Receive Date:	10-AUG-17			
Collector:	Client			

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	Jd	1.08	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	ADM-S-OC	Project:	EVHI03017
Sample ID:	430306003	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 10:12		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average	J	0.915	0.330	1.00	mg/L		1	TSM	08/17/17	1746	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	ADM-B-BOD	Project:	EVHI03017
Sample ID:	430306004	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 10:23		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	Jd	1.03	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	ADM-B-OC	Project:	EVHI03017
Sample ID:	430306005	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 10:23		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average	J	0.835	0.330	1.00	mg/L		1	TSM	08/17/17	1810	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-S-PO4	Project:	EVHI03017
Sample ID:	430306006	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 12:54		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.626	0.033	0.100	mg/L	1.00	1	KLP1	08/24/17	1611	1692768	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.266	0.007	0.020	mg/L		1	AXH3	08/16/17	0951	1690783	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.0524	0.020	0.050	mg/L	1.00	1	KLP1	08/23/17	1041	1692784	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		892	33.0	100	ug/L		1	KLP1	08/24/17	1634	1692013	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	08/23/17	1700	1692765
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	08/22/17	1700	1692782

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-S-BOD	Project:	EVHI03017
Sample ID:	430306007	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 12:54		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY		2.35	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-S-OC	Project:	EVHI03017
Sample ID:	430306008	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 12:54		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		3.57	0.330	1.00	mg/L		1	TSM	08/17/17	1833	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-B-BOD	Project:	EVHI03017
Sample ID:	430306009	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:08		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	J	1.92	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-B-OC	Project:	EVHI03017
Sample ID:	430306010	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:08		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		2.51	0.330	1.00	mg/L		1	TSM	08/17/17	1856	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID:	KM-S-PO4	Project:	EVHI03017
Sample ID:	430306011	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:30		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.626	0.033	0.100	mg/L	1.00	1	KLP1	08/24/17	1612	1692768	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.304	0.007	0.020	mg/L		1	AXH3	08/16/17	0957	1690783	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.0676	0.020	0.050	mg/L	1.00	1	KLP1	08/23/17	1042	1692784	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		930	33.0	100	ug/L		1	KLP1	08/24/17	1634	1692013	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	08/23/17	1700	1692765
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	08/22/17	1700	1692782

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID:	KM-S-BOD	Project:	EVHI03017
Sample ID:	430306012	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:30		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY		2.29	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	KM-S-OC	Project:	EVHI03017
Sample ID:	430306013	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:30		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		4.42	0.330	1.00	mg/L		1	TSM	08/17/17	1920	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	KM-B-BOD	Project:	EVHI03017
Sample ID:	430306014	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:37		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	e	3.02	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	KM-B-OC	Project:	EVHI03017
Sample ID:	430306015	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 13:37		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		3.46	0.330	1.00	mg/L		1	TSM	08/17/17	1943	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID: CFBW-S-PO4
Project: EVHI03017
Sample ID: 430306016
Client ID: EVHI001
Matrix: Water
Collect Date: 09-AUG-17 14:21
Receive Date: 10-AUG-17
Collector: Client

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.556	0.033	0.100	mg/L	1.00	1	KLP1	08/24/17	1613	1692768	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.410	0.007	0.020	mg/L		1	AXH3	08/16/17	0958	1690783	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.128	0.020	0.050	mg/L	1.00	1	KLP1	08/23/17	1042	1692784	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		966	33.0	100	ug/L		1	KLP1	08/24/17	1634	1692013	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	08/23/17	1700	1692765
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	08/22/17	1700	1692782

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID:	CFBW-S-BOD	Project:	EVHI03017
Sample ID:	430306017	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:21		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	Jd	1.15	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	CFBW-S-OC	Project:	EVHI03017
Sample ID:	430306018	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:21		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		9.96	0.330	1.00	mg/L		1	TSM	08/17/17	2030	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID:	CFBW-B-BOD	Project:	EVHI03017
Sample ID:	430306019	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:17		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	J	1.24	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	CFBW-B-OC	Project:	EVHI03017
Sample ID:	430306020	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:17		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		6.07	0.330	1.00	mg/L		1	TSM	08/17/17	2053	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-S-PO4	Project:	EVHI03017
Sample ID:	430306021	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:56		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.574	0.033	0.100	mg/L	1.00	1	KLP1	08/24/17	1614	1692768	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.176	0.007	0.020	mg/L		1	AXH3	08/16/17	0959	1690783	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P	J	0.0406	0.020	0.050	mg/L	1.00	1	KLP1	08/23/17	1043	1692784	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		750	33.0	100	ug/L		1	KLP1	08/24/17	1634	1692013	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	08/23/17	1700	1692765
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	08/22/17	1700	1692782

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-S-BOD	Project:	EVHI03017
Sample ID:	430306022	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:56		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY		2.45	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-S-OC	Project:	EVHI03017
Sample ID:	430306023	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:56		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		9.97	0.330	1.00	mg/L		1	TSM	08/17/17	2116	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID: NECF-B-BOD
Sample ID: 430306024
Matrix: Water
Collect Date: 09-AUG-17 14:51
Receive Date: 10-AUG-17
Collector: Client

Project: EVHI03017
Client ID: EVHI001

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Micro-biology												
SM 5210B BOD, 5DAY "As Received"												
BOD, 5 DAY	J	1.97	1.00	2.00	mg/L			AXF2	08/11/17	0830	1690746	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5210B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration

Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: August 24, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-B-OC	Project:	EVHI03017
Sample ID:	430306025	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	09-AUG-17 14:51		
Receive Date:	10-AUG-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		7.64	0.330	1.00	mg/L		1	TSM	08/17/17	2140	1692120	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	08/15/17	1200	1690770

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

QC Summary

Report Date: August 24, 2017

RPS Evans-Hamilton
3319 Maybank Highway
Charleston, South Carolina
Contact: **Mr. Nathan West**

Workorder: **430306**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Carbon Analysis										
Batch 1692120										
QC1203851712 FLTB										
Dissolved Organic Carbon Average			U	ND	mg/L				TSM	08/17/17 17:12
QC1203855146 LCS										
Dissolved Organic Carbon Average	10.0			9.52	mg/L		95.2	(80%-120%)		08/17/17 17:23
QC1203855147 LCSD										
Dissolved Organic Carbon Average	10.0			9.68	mg/L	1.64	96.8	(0%-20%)		08/17/17 17:35
QC1203855185 MB										
Dissolved Organic Carbon Average			U	ND	mg/L					08/17/17 17:00
Micro-biology										
Batch 1690746										
QC1203851669 430306002 DUP										
BOD, 5 DAY		Jd 1.08	Jd	1.06	mg/L	1.87 ^		(+/-2.00)	AXF2	08/11/17 08:30
QC1203851667 LCS										
BOD, 5 DAY	198			202	mg/L		102	(85%-115%)		08/11/17 08:30
QC1203851666 MB										
BOD, 5 DAY				-0.065	mg/L					08/11/17 08:30
QC1203851668 SEED										
BOD, 5 DAY				0.758	mg/L					08/11/17 08:30
Nutrient Analysis										
Batch 1690783										
QC1203851752 429924007 DUP										
Nitrogen, Nitrate/Nitrite		8.48		8.35	mg/L	1.49		(0%-20%)	AXH3	08/16/17 08:27

QC Summary

Workorder: **430306**

Parmname	NOM		Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Nutrient Analysis											
Batch 1690783											
QC1203851750 LCS											
Nitrogen, Nitrate/Nitrite	1.00				1.02	mg/L		102	(90%-110%)	AXH3	08/16/17 08:24
QC1203851749 MB											
Nitrogen, Nitrate/Nitrite				U	ND	mg/L					08/16/17 08:23
QC1203851755 429924007 PS											
Nitrogen, Nitrate/Nitrite	1.00		0.339		1.36	mg/L		102	(90%-110%)		08/16/17 08:28
Batch 1692768											
QC1203856512 430642003 DUP											
Nitrogen, Total Kjeldahl		U	ND	U	ND	mg/L	N/A			KLP1	08/24/17 16:51
QC1203856509 LCS											
Nitrogen, Total Kjeldahl	1.00				0.985	mg/L		98.5	(90%-110%)		08/24/17 16:10
QC1203856508 MB											
Nitrogen, Total Kjeldahl				U	ND	mg/L					08/24/17 16:09
QC1203856513 430642003 MS											
Nitrogen, Total Kjeldahl	8.00	U	ND		7.20	mg/L		90	(90%-110%)		08/24/17 16:52
Batch 1692784											
QC1203856569 429528004 DUP											
Phosphorus, Total as P		J	0.0468		0.0615	mg/L	27.1 ^		(+/-0.050)	KLP1	08/23/17 10:25
QC1203856567 LCS											
Phosphorus, Total as P	1.00				1.03	mg/L		103	(80%-124%)		08/23/17 10:18
QC1203856566 MB											
Phosphorus, Total as P				U	ND	mg/L					08/23/17 10:17
QC1203856572 429528004 MS											
Phosphorus, Total as P	1.00	J	0.0468		1.12	mg/L		107	(63%-139%)		08/23/17 10:25

QC Summary

Workorder: **430306**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

Notes:

The Qualifiers in this report are defined as follows:

<	Result is less than value reported
>	Result is greater than value reported
B	The target analyte was detected in the associated blank.
E	General Chemistry--Concentration of the target analyte exceeds the instrument calibration range
H	Analytical holding time was exceeded
J	Value is estimated
N/A	RPD or %Recovery limits do not apply.
N1	See case narrative
ND	Analyte concentration is not detected above the detection limit
NJ	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Q	One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
R	Per section 9.3.4.1 of Method 1664 Revision B, due to matrix spike recovery issues, this result may not be reported or used for regulatory compliance purposes.
R	Sample results are rejected
U	Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
X	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Z	Paint Filter Test--Particulates passed through the filter, however no free liquids were observed.
^	RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
d	5-day BOD--The 2:1 depletion requirement was not met for this sample
e	5-day BOD--Test replicates show more than 30% difference between high and low values. The data is qualified per the method and can be used for reporting purposes
h	Preparation or preservation holding time was exceeded

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 − (843) 556−8171 − www.gel.com

Certificate of Analysis Report
for

EVHI001 RPS Evans Hamilton

Client SDG: 432539 GEL Work Order: 432539

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria

** Analyte is a Tracer compound

** Analyte is a surrogate compound

U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the ’U’ qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Jake Crook.

Reviewed by ____

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	ADM-B DOC	Project:	EVHI03017
Sample ID:	432539001	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 07:25		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		1.98	0.330	1.00	mg/L		1	TSM	09/15/17	0435	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID:	ADM-S	Project:	EVHI03017
Sample ID:	432539002	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 07:58		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		1.10	0.033	0.100	mg/L	1.00	1	KLP1	09/14/17	1028	1699984	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.0757	0.007	0.020	mg/L		1	KLP1	09/13/17	1144	1700075	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.0634	0.020	0.050	mg/L	1.00	1	KLP1	09/13/17	1428	1699982	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		1180	33.0	100	ug/L		1	KLP1	09/14/17	1230	1700076	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	09/13/17	1300	1699983
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	09/13/17	1300	1699979

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	ADM-S DOC	Project:	EVHI03017
Sample ID:	432539003	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 07:58		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		1.88	0.330	1.00	mg/L		1	TSM	09/15/17	0458	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-B DOC	Project:	EVHI03017
Sample ID:	432539004	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 09:20		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		7.24	0.660	2.00	mg/L		2	TSM	09/15/17	0521	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-S	Project:	EVHI03017
Sample ID:	432539005	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 08:45		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		1.07	0.033	0.100	mg/L	1.00	1	KLP1	09/14/17	1029	1699984	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.255	0.007	0.020	mg/L		1	KLP1	09/13/17	1145	1700075	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.130	0.020	0.050	mg/L	1.00	1	KLP1	09/13/17	1429	1699982	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		1330	33.0	100	ug/L		1	KLP1	09/14/17	1230	1700076	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	09/13/17	1300	1699983
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	09/13/17	1300	1699979

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	UBI-S DOC	Project:	EVHI03017
Sample ID:	432539006	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 08:45		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		10.5	0.660	2.00	mg/L		2	TSM	09/15/17	0545	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	KM-B DOC	Project:	EVHI03017
Sample ID:	432539007	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 09:58		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		13.6	0.660	2.00	mg/L		2	TSM	09/15/17	0631	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID: KM-S
Sample ID: 432539008
Matrix: Water
Collect Date: 07-SEP-17 10:04
Receive Date: 08-SEP-17
Collector: Client

Project: EVHI03017
Client ID: EVHI001

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.765	0.033	0.100	mg/L	1.00	1	KLP1	09/14/17	1030	1699984	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.244	0.007	0.020	mg/L		1	KLP1	09/13/17	1147	1700075	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.154	0.020	0.050	mg/L	1.00	1	KLP1	09/13/17	1430	1699982	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		1010	33.0	100	ug/L		1	KLP1	09/14/17	1230	1700076	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	09/13/17	1300	1699983
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	09/13/17	1300	1699979

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	KM-S DOC	Project:	EVHI03017
Sample ID:	432539009	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 10:04		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		16.0	0.660	2.00	mg/L		2	TSM	09/15/17	0655	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-B DOC	Project:	EVHI03017
Sample ID:	432539010	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 11:22		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		28.8	0.660	2.00	mg/L		2	TSM	09/15/17	0805	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-S	Project:	EVHI03017
Sample ID:	432539011	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 11:12		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.972	0.033	0.100	mg/L	1.00	1	KLP1	09/14/17	1031	1699984	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.0807	0.007	0.020	mg/L		1	KLP1	09/13/17	1148	1700075	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.407	0.020	0.050	mg/L	1.00	1	KLP1	09/13/17	1437	1699982	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		1050	33.0	100	ug/L		1	KLP1	09/14/17	1230	1700076	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	09/13/17	1300	1699983
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	09/13/17	1300	1699979

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
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Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway
	Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	NECF-S DOC	Project:	EVHI03017
Sample ID:	432539012	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 11:12		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		26.7	0.660	2.00	mg/L		2	TSM	09/15/17	0828	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company : RPS Evans-Hamilton
Address : 3319 Maybank Highway

Charleston, South Carolina 29455
Contact: Mr. Nathan West
Project: Cape Fear River August/September Events

Client Sample ID: CFBW-B DOC
Sample ID: 432539013
Matrix: Water
Collect Date: 07-SEP-17 12:12
Receive Date: 08-SEP-17
Collector: Client

Project: EVHI03017
Client ID: EVHI001

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		14.3	0.330	1.00	mg/L		1	TSM	09/15/17	0851	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:
DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	CFBW-S	Project:	EVHI03017
Sample ID:	432539014	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 12:25		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Nutrient Analysis												
EPA 351.2, Nitrogen, Total Kjeldahl (TKN) "As Received"												
Nitrogen, Total Kjeldahl		0.640	0.033	0.100	mg/L	1.00	1	KLP1	09/14/17	1036	1699984	1
EPA 353.2 Nitrogen, Nitrate/Nitrite "As Received"												
Nitrogen, Nitrate/Nitrite		0.435	0.007	0.020	mg/L		1	KLP1	09/13/17	1149	1700075	2
EPA 365.4 Phosphorus, Total "As Received"												
Phosphorus, Total as P		0.231	0.020	0.050	mg/L	1.00	1	KLP1	09/13/17	1438	1699982	3
EPA 351.2/353.2 Total Nitrogen "See Parent Products"												
Total Nitrogen		1080	33.0	100	ug/L		1	KLP1	09/14/17	1230	1700076	4

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 351.2 Prep	EPA 351.2 Total Kjeldahl Nitrogen Prep	KLP1	09/13/17	1300	1699983
EPA 365.4 Prep	EPA 365.4 Phosphorus, Total in liquid PR	KLP1	09/13/17	1300	1699979

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 351.2	
2	EPA 353.2 Low Level	
3	EPA 365.4	
4	EPA 351.2/353.2	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Certificate of Analysis

Report Date: September 20, 2017

Company :	RPS Evans-Hamilton
Address :	3319 Maybank Highway Charleston, South Carolina 29455
Contact:	Mr. Nathan West
Project:	Cape Fear River August/September Events

Client Sample ID:	CFBW-S DOC	Project:	EVHI03017
Sample ID:	432539015	Client ID:	EVHI001
Matrix:	Water		
Collect Date:	07-SEP-17 12:25		
Receive Date:	08-SEP-17		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Carbon Analysis												
SM 5310 B Dissolved Organic Carbon "As Received"												
Dissolved Organic Carbon Average		13.8	0.330	1.00	mg/L		1	TSM	09/15/17	0915	1699846	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 160	Laboratory Filtration	EXF1	09/13/17	1200	1699737

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	SM 5310 B	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

QC Summary

Report Date: September 20, 2017

RPS Evans-Hamilton
3319 Maybank Highway
Charleston, South Carolina
Contact: **Mr. Nathan West**

Workorder: **432539**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Carbon Analysis										
Batch 1699846										
QC1203873731 432539009 DUP										
Dissolved Organic Carbon Average		16.0		16.0	mg/L	0.0874		(0%-20%)	TSM	09/15/17 07:18
QC1203872615 FLTB										
Dissolved Organic Carbon Average			U	ND	mg/L					09/15/17 03:01
QC1203873729 LCS										
Dissolved Organic Carbon Average	10.0			9.88	mg/L		98.8	(80%-120%)		09/15/17 03:13
QC1203873728 MB										
Dissolved Organic Carbon Average			U	ND	mg/L					09/15/17 02:50
QC1203873733 432539009 PS										
Dissolved Organic Carbon Average	10.0	8.01		17.6	mg/L		95.6	(65%-120%)		09/15/17 07:41
Nutrient Analysis										
Batch 1699982										
QC1203873259 432275001 DUP										
Phosphorus, Total as P		0.0606		0.098	mg/L	47.2 ^		(+/-0.050)	KLP1	09/13/17 14:12
QC1203873258 LCS										
Phosphorus, Total as P	1.00			1.10	mg/L		110	(80%-124%)		09/13/17 14:10
QC1203873257 MB										
Phosphorus, Total as P			U	ND	mg/L					09/13/17 14:35
QC1203873261 432275001 MS										
Phosphorus, Total as P	1.00	0.0606		1.11	mg/L		105	(63%-139%)		09/13/17 14:13

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QC Summary

Workorder: **432539**

Parmname	NOM		Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Nutrient Analysis											
Batch 1699984											
QC1203873270 432325003 DUP											
Nitrogen, Total Kjeldahl		U	ND	U	ND	mg/L	N/A			KLP1	09/14/17 10:13
QC1203873269 LCS											
Nitrogen, Total Kjeldahl	1.00				1.03	mg/L		103	(90%-110%)		09/14/17 10:37
QC1203873268 MB											
Nitrogen, Total Kjeldahl				U	ND	mg/L					09/14/17 10:11
QC1203873273 432325003 MS											
Nitrogen, Total Kjeldahl	1.00	U	ND		1.10	mg/L		110	(90%-110%)		09/14/17 10:14
Batch 1700075											
QC1203873616 432318001 DUP											
Nitrogen, Nitrate/Nitrite			0.0558		0.0553	mg/L	0.9 ^		(+/-0.050)	KLP1	09/13/17 11:16
QC1203873615 LCS											
Nitrogen, Nitrate/Nitrite	1.00				0.999	mg/L		99.9	(90%-110%)		09/13/17 11:09
QC1203873614 MB											
Nitrogen, Nitrate/Nitrite				U	ND	mg/L					09/13/17 11:07
QC1203873620 432318001 PS											
Nitrogen, Nitrate/Nitrite	1.00		0.0558		1.11	mg/L		105	(90%-110%)		09/13/17 11:17

Notes:

The Qualifiers in this report are defined as follows:

<	Result is less than value reported
>	Result is greater than value reported
B	The target analyte was detected in the associated blank.
E	General Chemistry--Concentration of the target analyte exceeds the instrument calibration range
H	Analytical holding time was exceeded
J	Value is estimated
N/A	RPD or %Recovery limits do not apply.

QC Summary

Workorder: **432539**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

N1	See case narrative
ND	Analyte concentration is not detected above the detection limit
NJ	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Q	One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
R	Per section 9.3.4.1 of Method 1664 Revision B, due to matrix spike recovery issues, this result may not be reported or used for regulatory compliance purposes.
R	Sample results are rejected
U	Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
X	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Z	Paint Filter Test--Particulates passed through the filter, however no free liquids were observed.
^	RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
d	5-day BOD--The 2:1 depletion requirement was not met for this sample
e	5-day BOD--Test replicates show more than 30% difference between high and low values. The data is qualified per the method and can be used for reporting purposes
h	Preparation or preservation holding time was exceeded

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

el1

elementOne

Element One Inc.
6319-D Carolina Beach Rd.
Wilmington, NC 28412

Phone: 910 793-0128
Fax: 910 792-6853
e1lab@e1lab.com

REPORT OF ANALYSES

Nathan West
RPS
3319 Maybank Highway
Charleston, SC 29455

October 19, 2017
Client Project Name Cape Fear WQ
Client Project Number
PO Number

Sample Matrix	WW	Sample Type		Date Received	09/07/17
Date Analyzed	09/08/17	Method	SM 5210B	Time Received	1650
Delivered by	Client			Received by	KMS

eOne ID	Sample ID	Parameter	Result	Unit	DL	Date Sampled	Time Sampled
30075-1	ADM-S	BOD-5	1.8	mg/L	*1.0	09/07/2017	0758
30075-2	ADM-B	BOD-5	1.8	mg/L	*1.0	09/07/2017	0725
30075-3	UBI-B	BOD-5	1.4	mg/L	*1.0	09/07/2017	0920
30075-4	UBI-S	BOD-5	< 1	mg/L	*1.0	09/07/2017	0845
30075-5	KM-B	BOD-5	< 1	mg/L	*1.0	09/07/2017	0958
30075-6	KM-S	BOD-5	< 1	mg/L	*1.0	09/07/2017	1004
30075-7	NECF-B	BOD-5	< 1	mg/L	*1.0	09/07/2017	1122
30075-8	NECF-S	BOD-5	< 1	mg/L	*1.0	09/07/2017	1112
30075-9	CFBW-B	BOD-5	< 1	mg/L	*1.0	09/07/2017	1212
30075-10	CFBW-S	BOD-5	< 1	mg/L	*1.0	09/07/2017	1225

*DL per client's specifications.

This is the first revision to this report; per the client's request the data was reported to a detection limit of 1.0mg/L.

Ken Smith, Laboratory Director

30075 RPS Report Packet Rev 10.19.17 Compiled by DBL

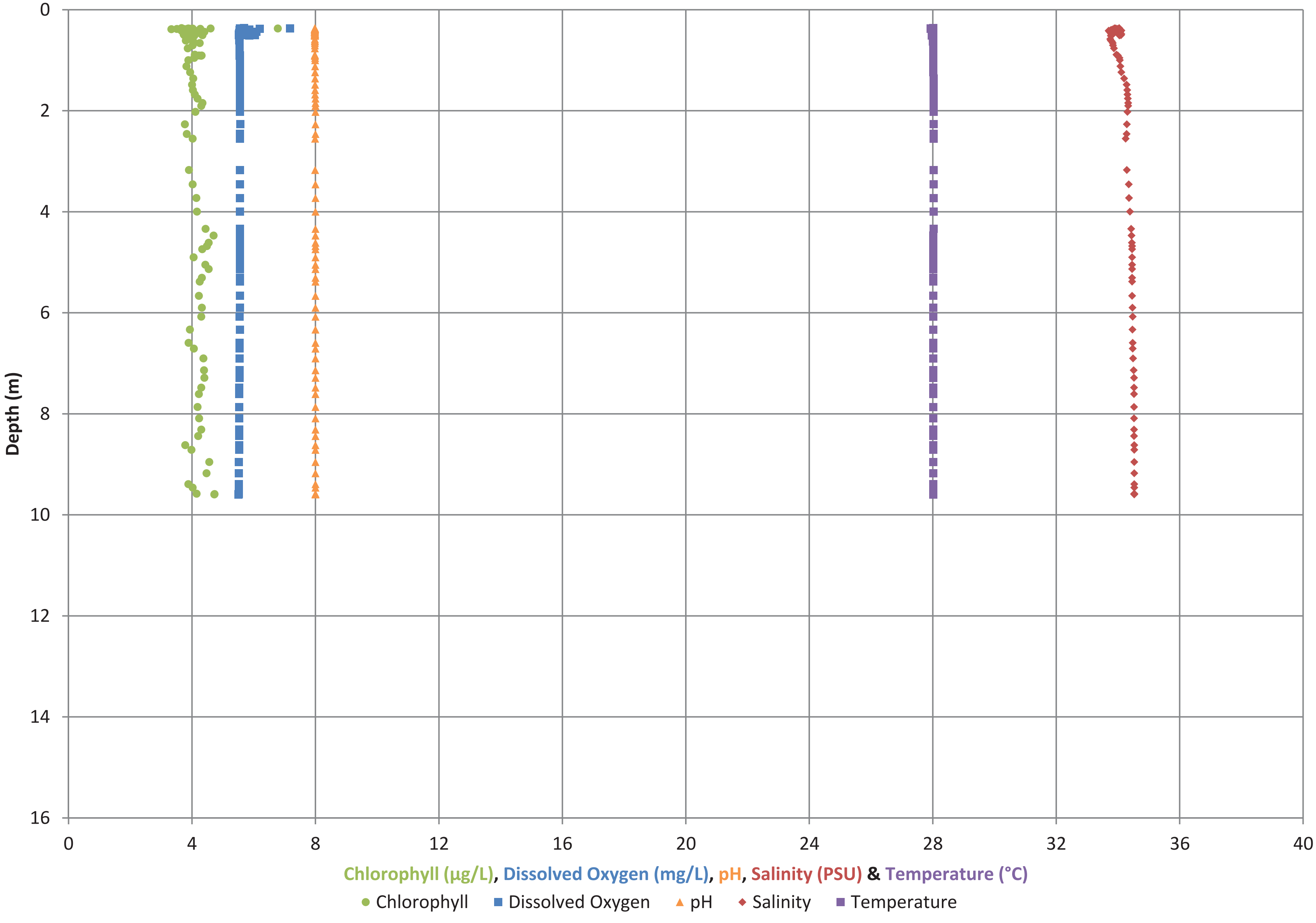
NC Certifications: DW 37788 and DWQ DENR 604

APPENDIX III Plots of CTD Data From Deployment

Date & Time 8/9/17 14:33

Cape Fear Water Quality Study

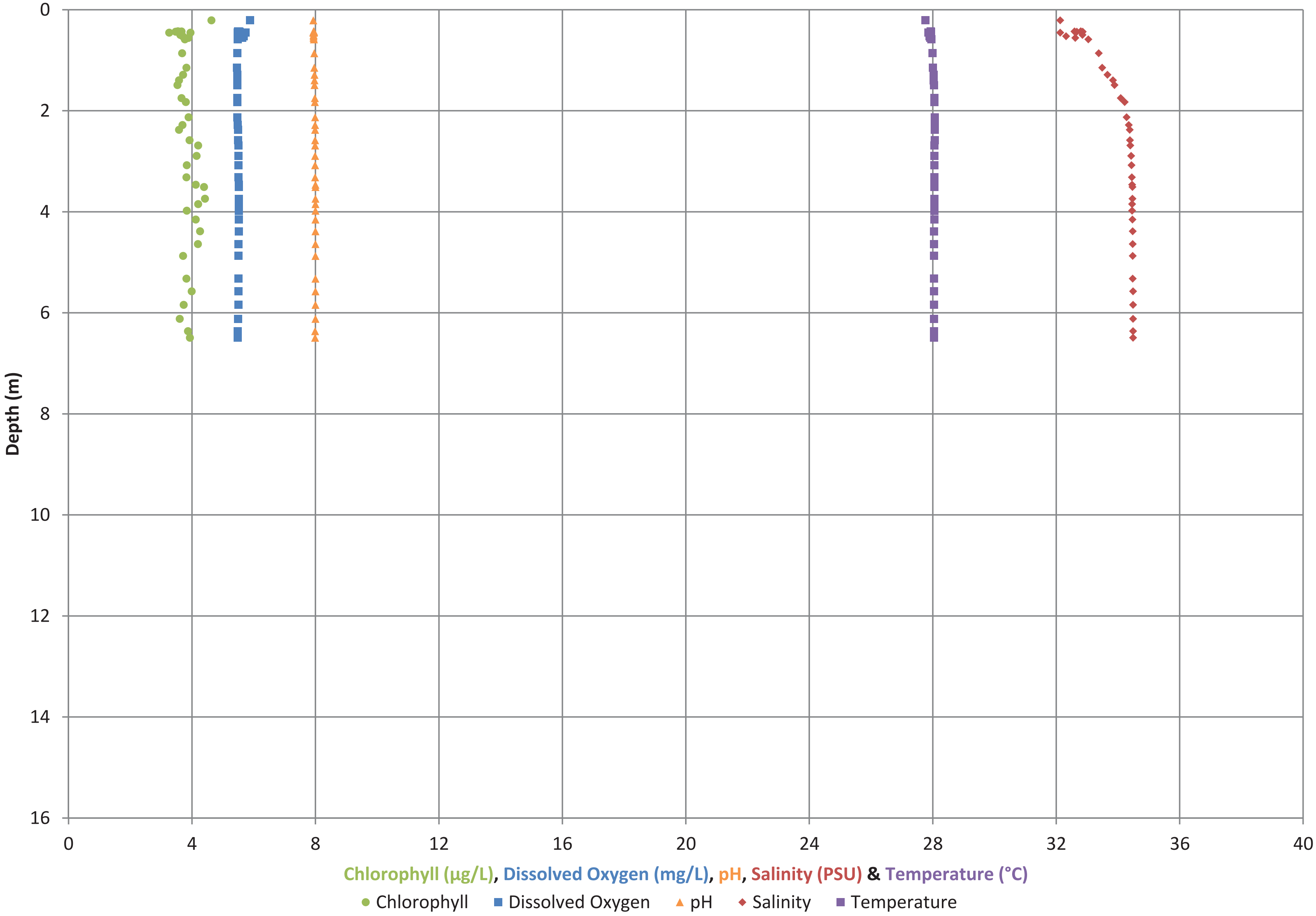
Location ADM B



Date & Time 8/9/17 14:29

Cape Fear Water Quality Study

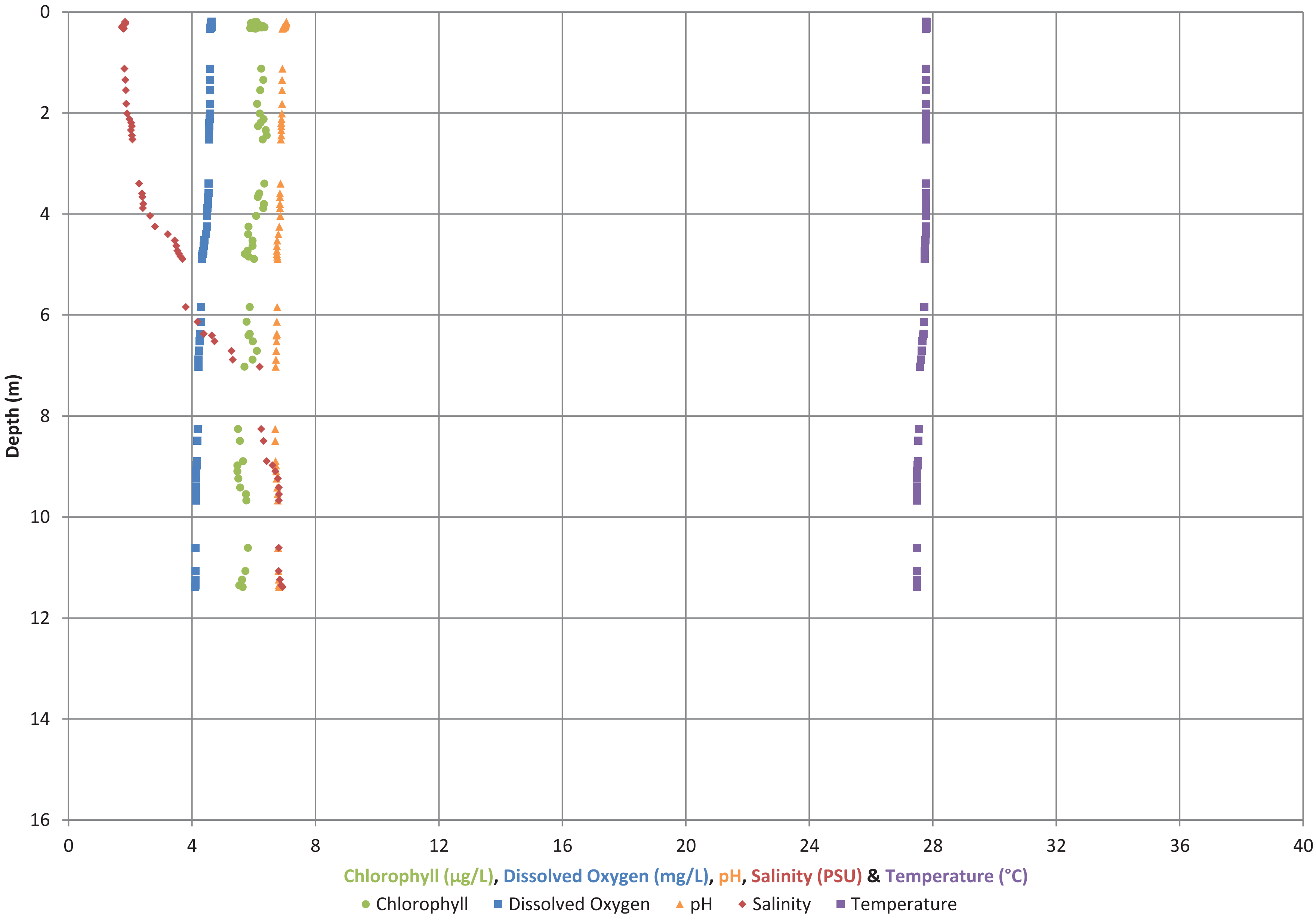
Location ADM S



Date & Time 8/9/17 18:20

Cape Fear Water Quality Study

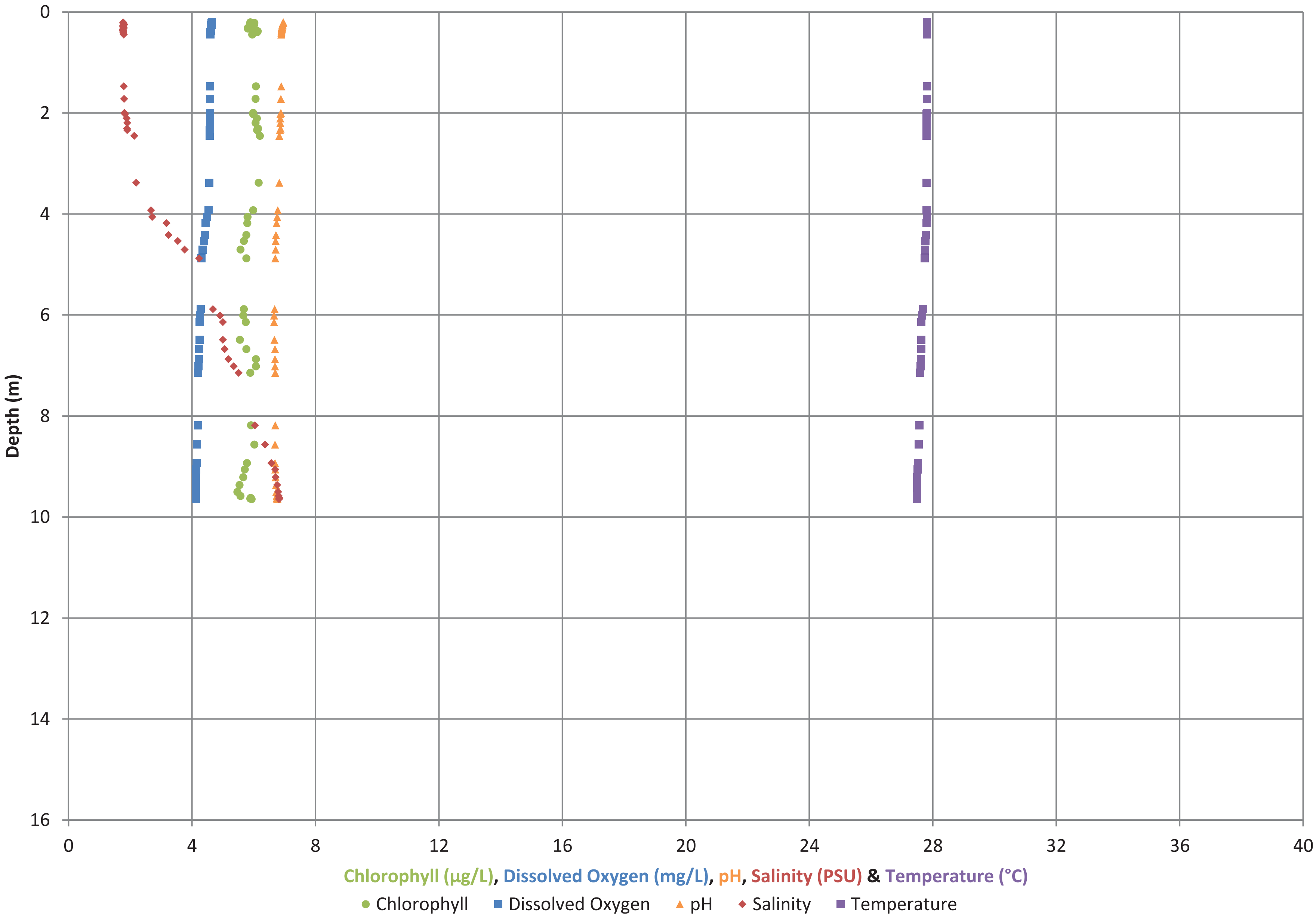
Location CFBW B



Date & Time 8/9/17 18:24

Cape Fear Water Quality Study

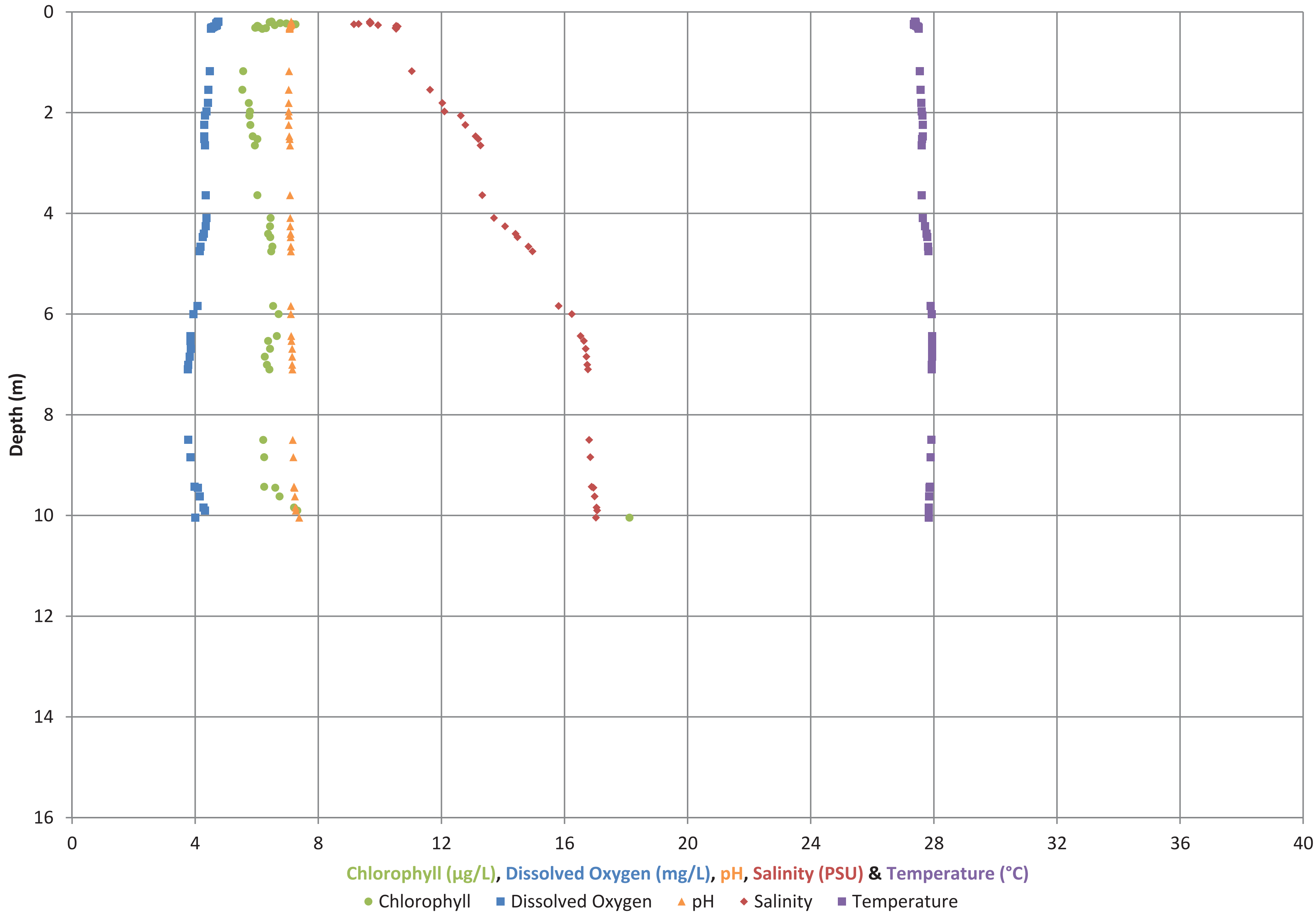
Location CFBW S



Date & Time 8/9/17 17:41

Cape Fear Water Quality Study

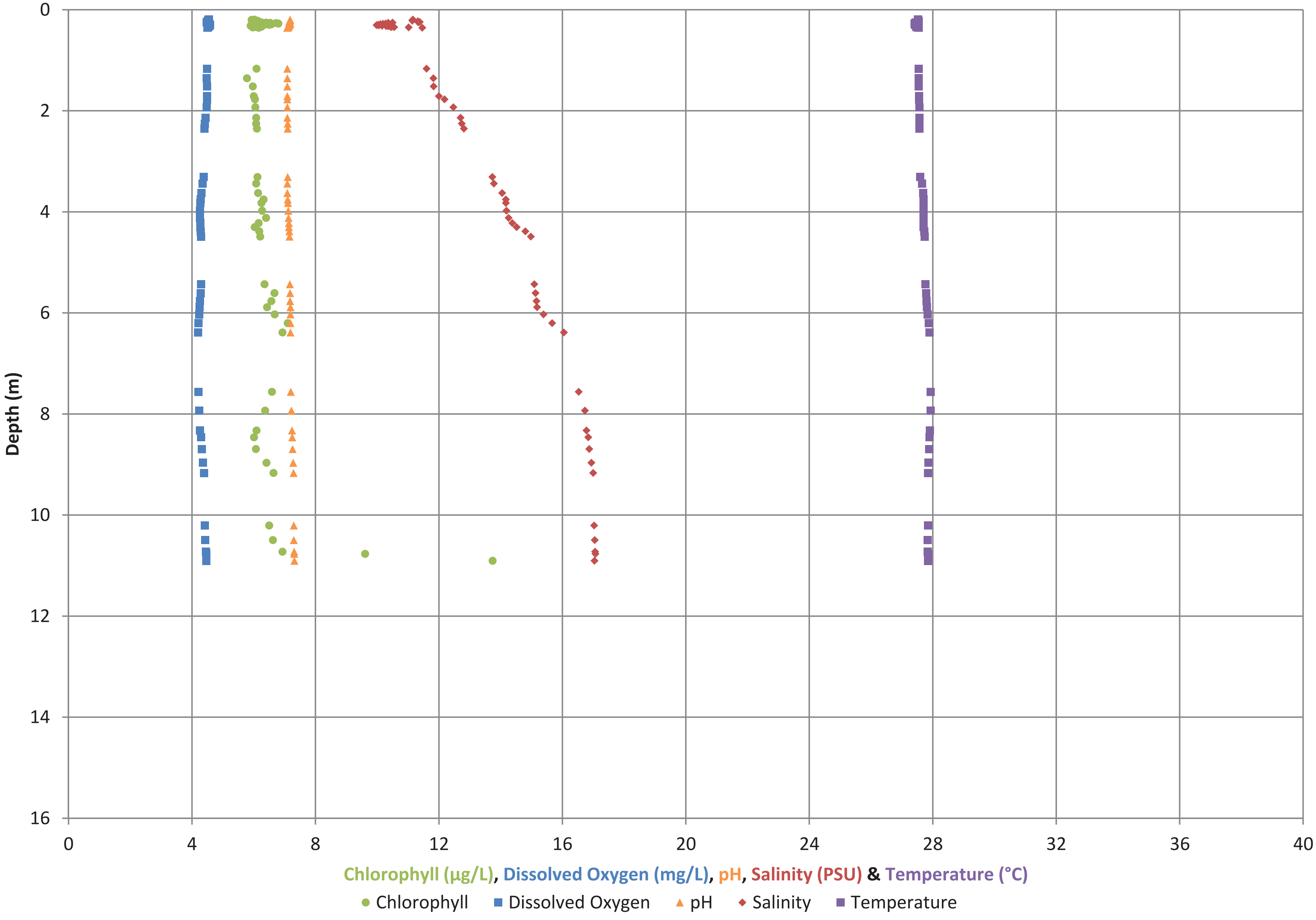
Location KM B



Date & Time 8/9/17 17:34

Cape Fear Water Quality Study

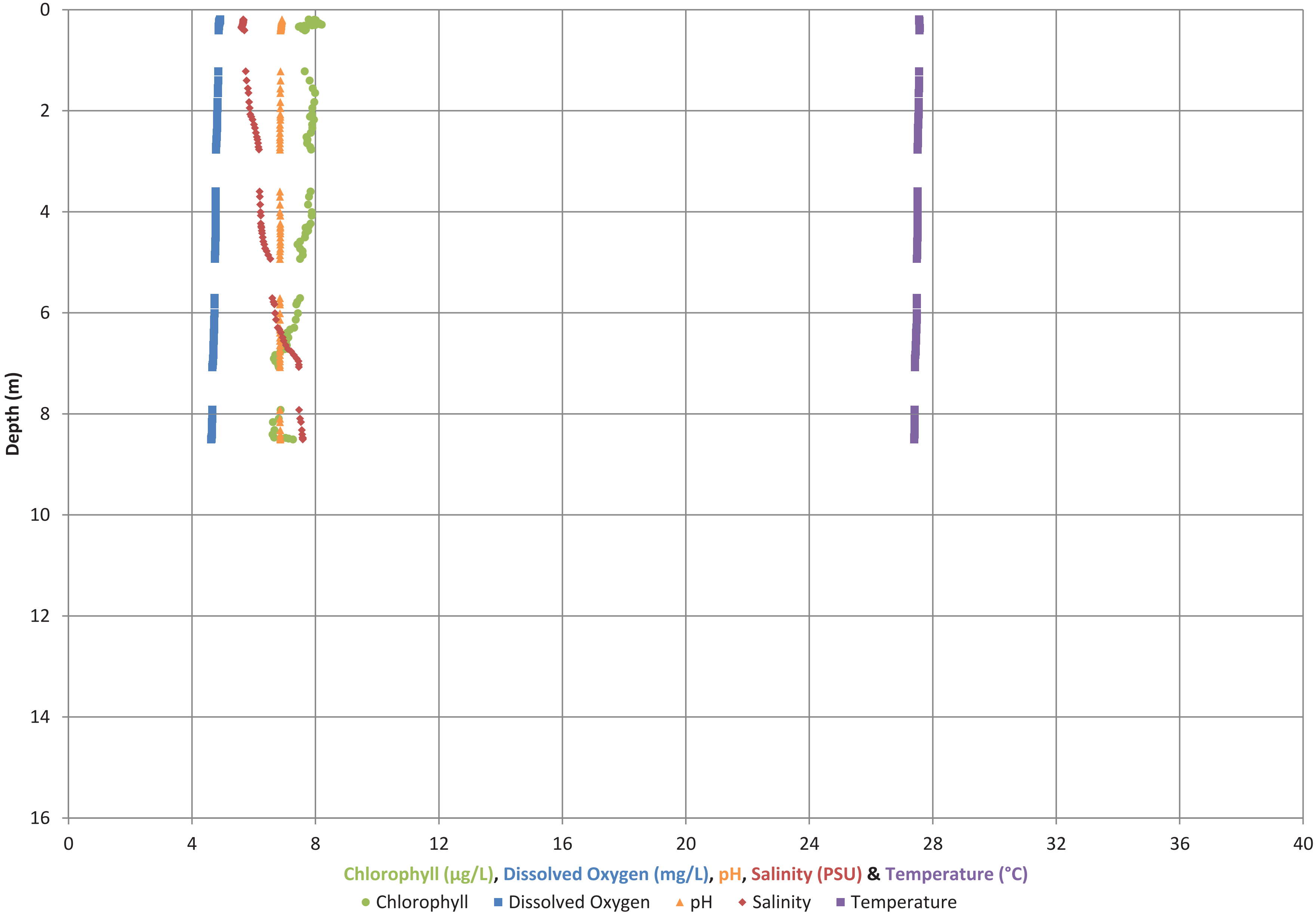
Location KM S



Date & Time 8/9/17 19:04

Cape Fear Water Quality Study

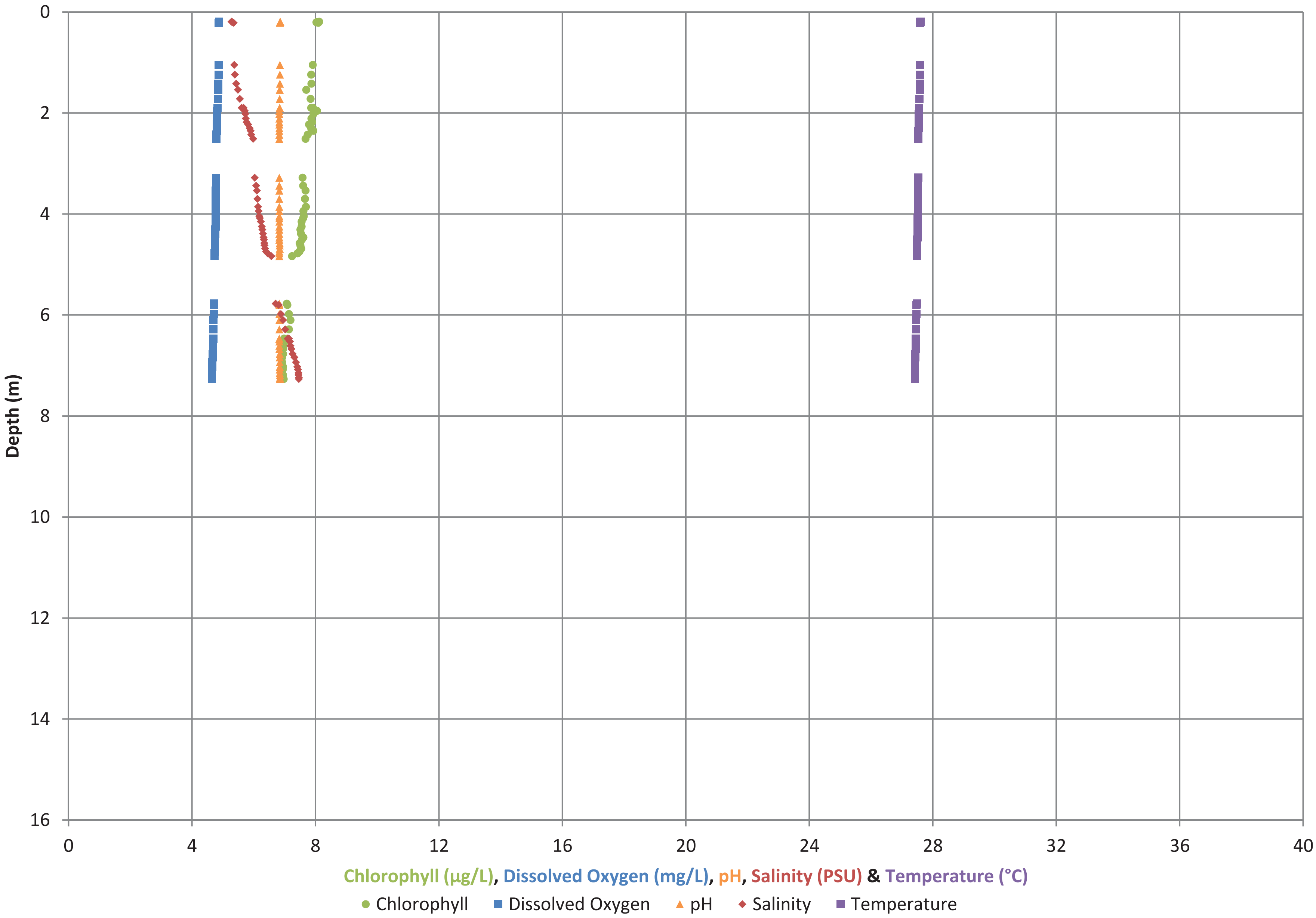
Location NECF 1



Date & Time 8/9/17 19:07

Cape Fear Water Quality Study

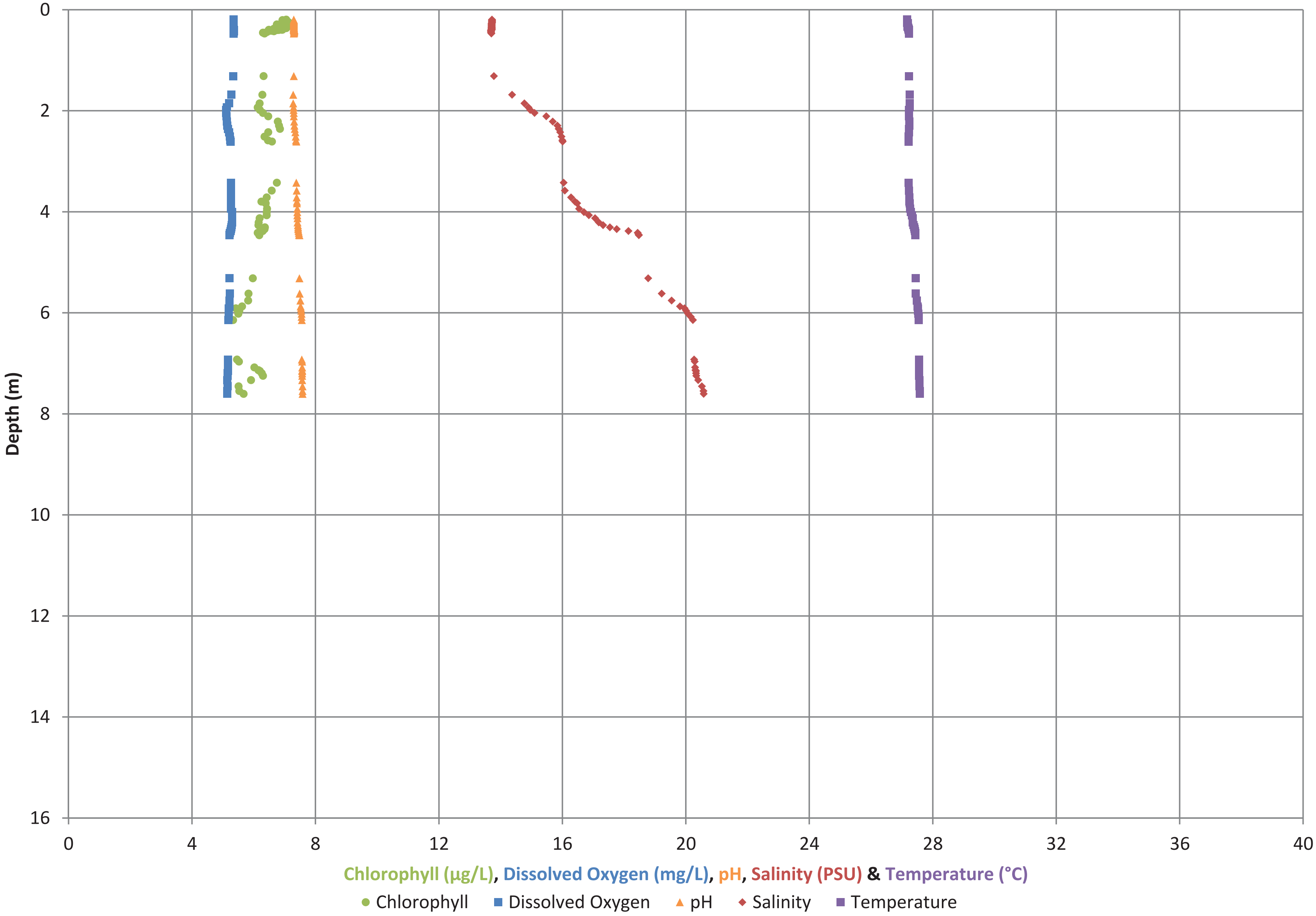
Location NECF 2



Date & Time 8/9/17 17:14

Cape Fear Water Quality Study

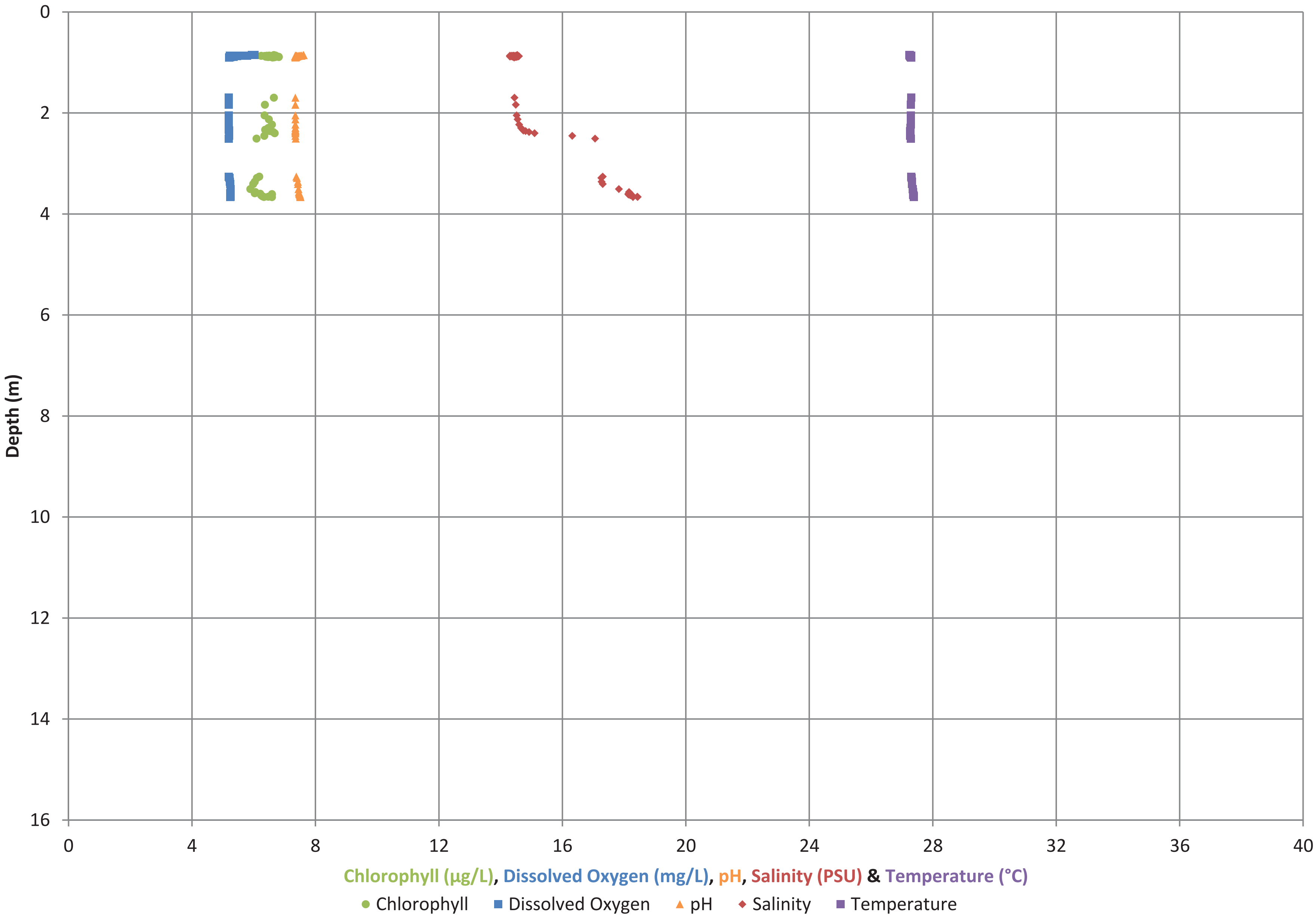
Location UBI B



Date & Time 8/9/17 17:04

Cape Fear Water Quality Study

Location UBI S

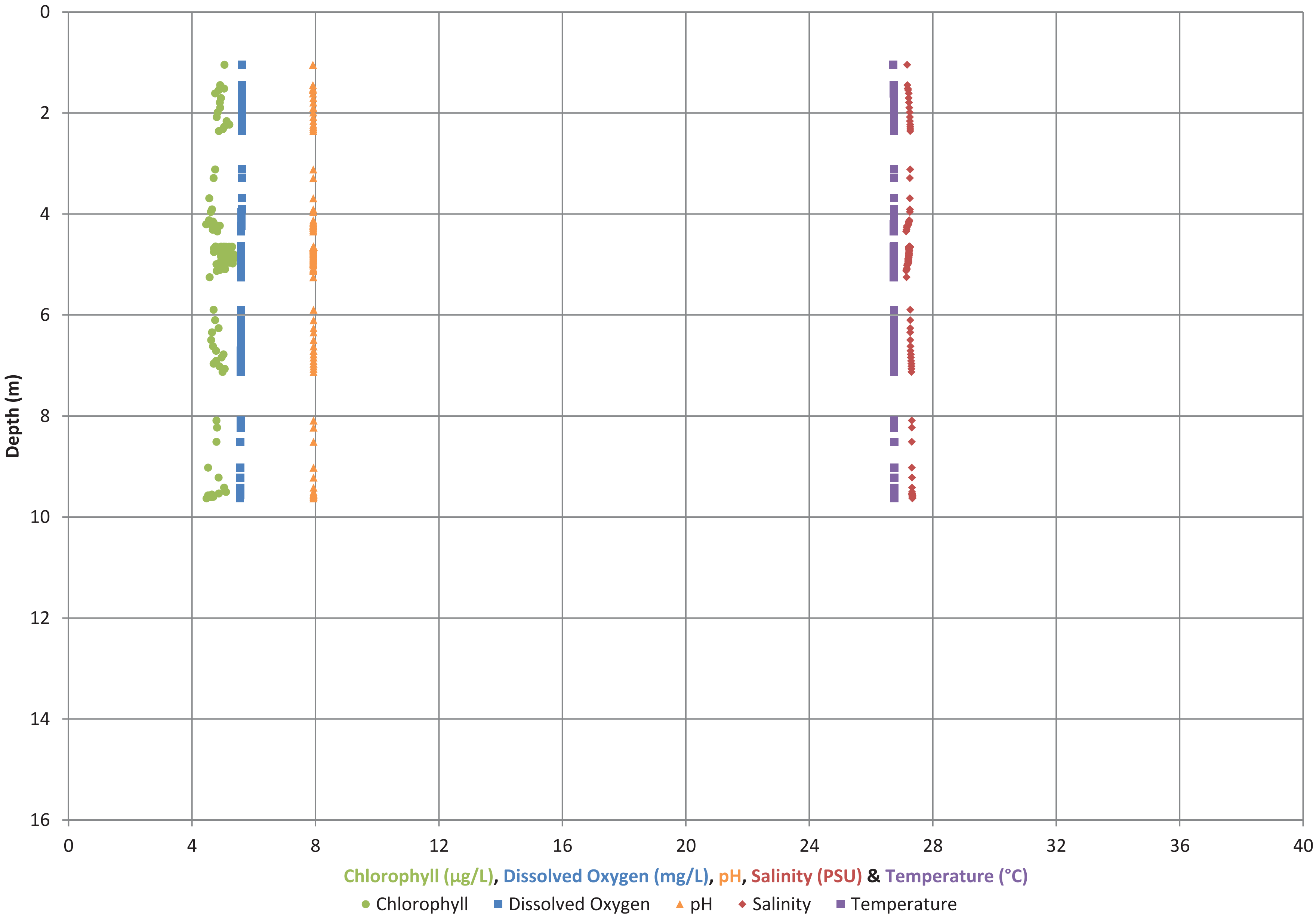


APPENDIX IV Plots of CTD Data From Recovery

Date & Time 9/7/17 11:33

Cape Fear Water Quality Study

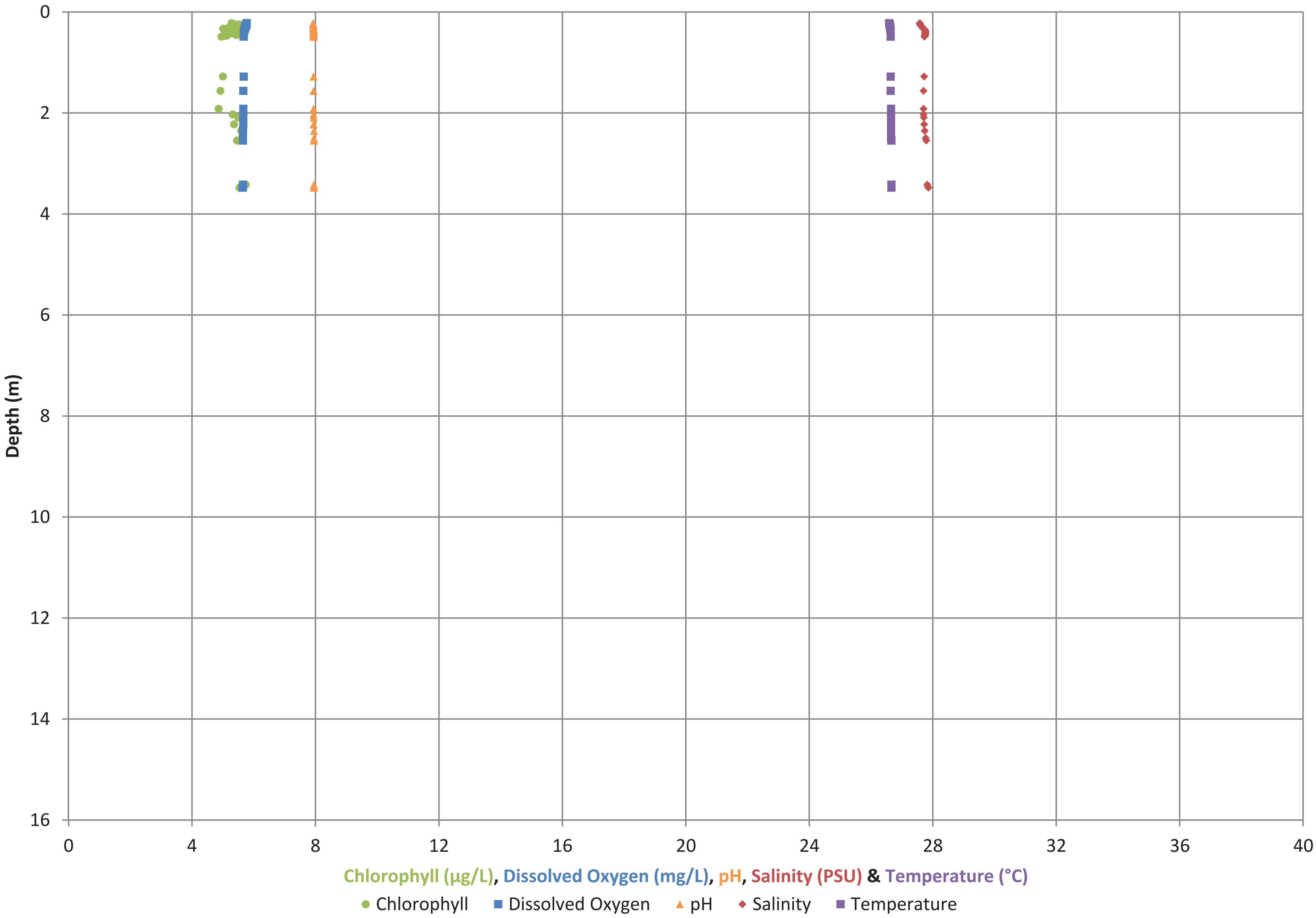
Location ADM B



Date & Time 9/7/17 11:57

Cape Fear Water Quality Study

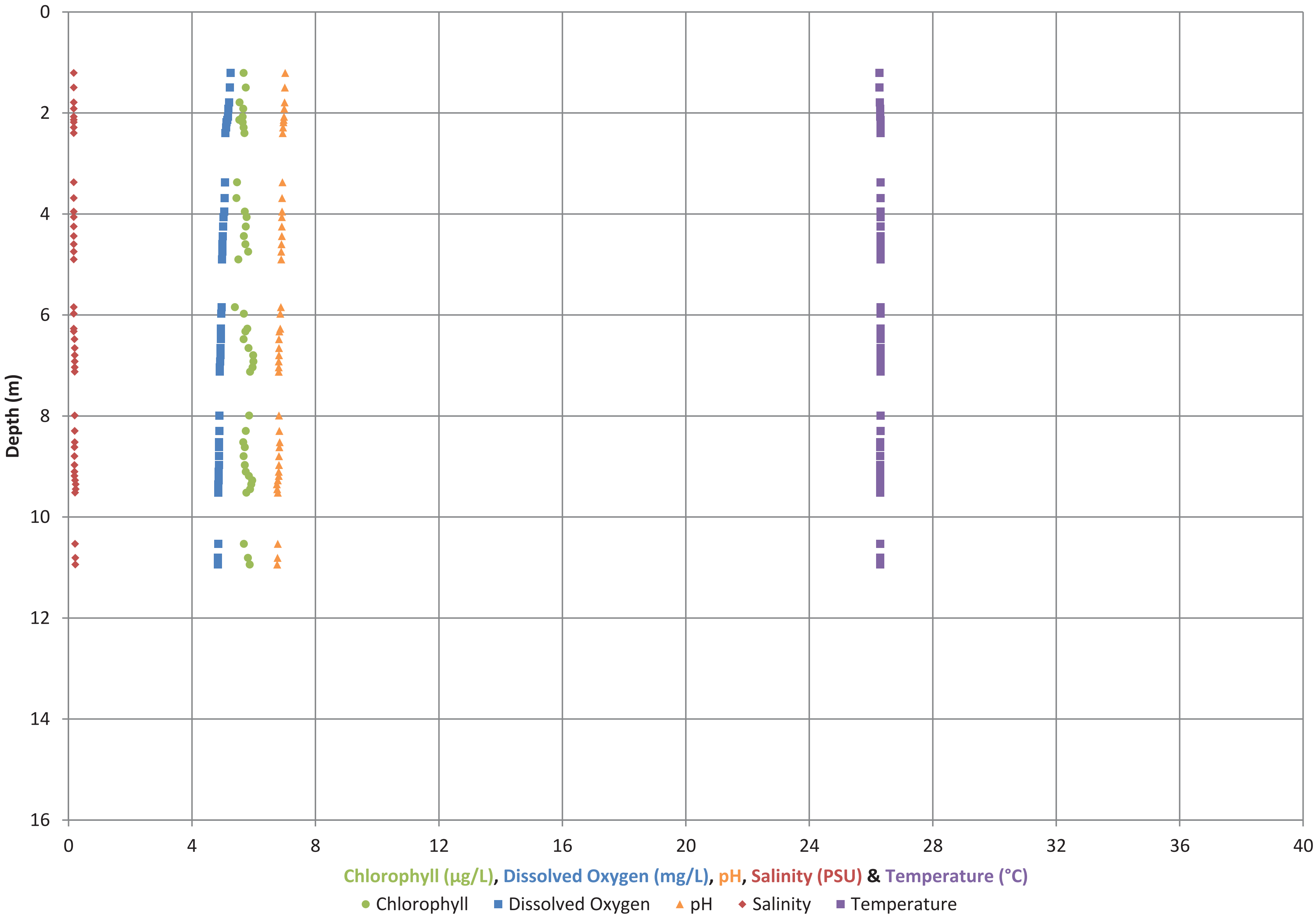
Location ADM S



Date & Time 9/7/17 16:11

Cape Fear Water Quality Study

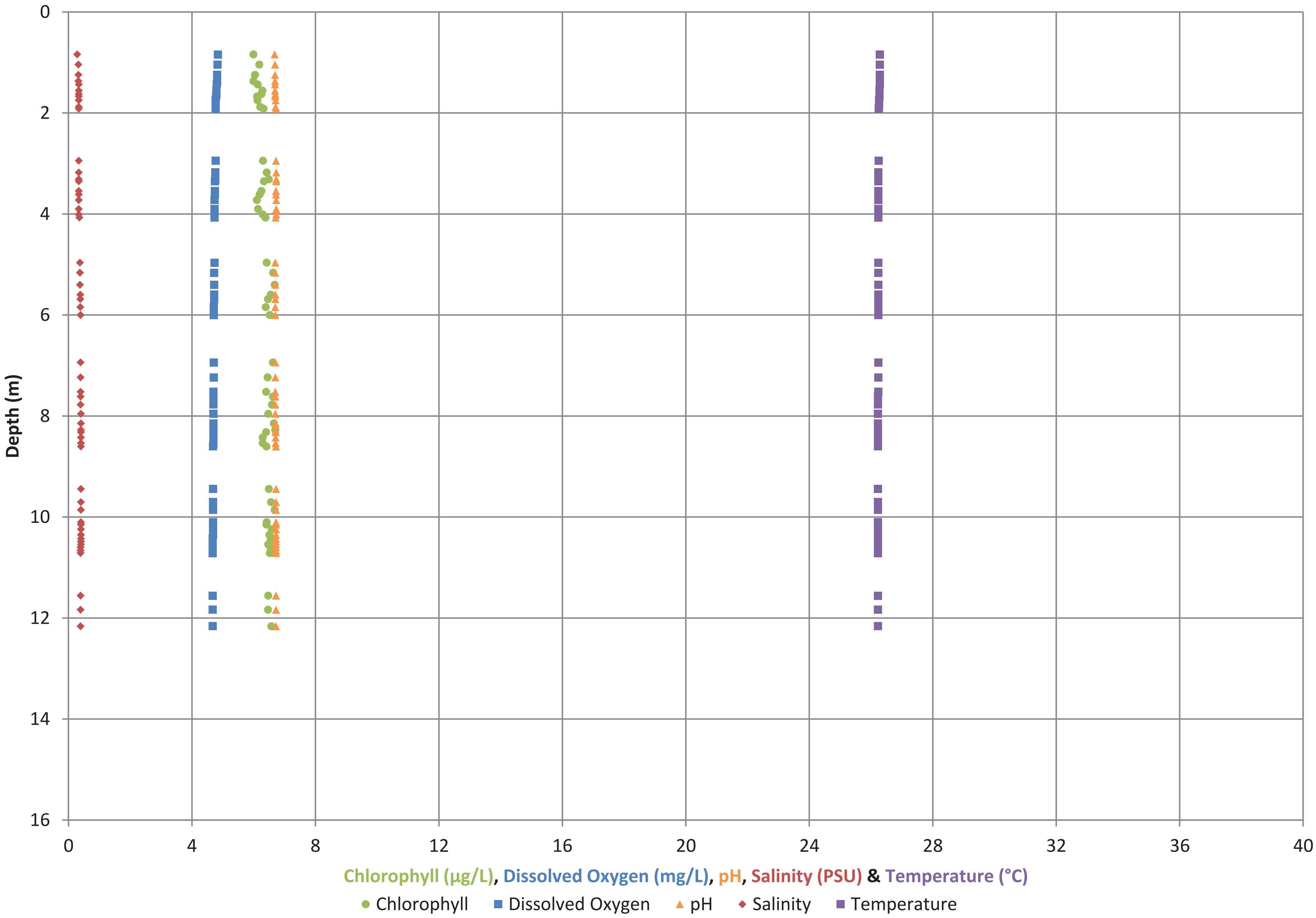
Location CFBW B



Date & Time 9/7/17 16:22

Cape Fear Water Quality Study

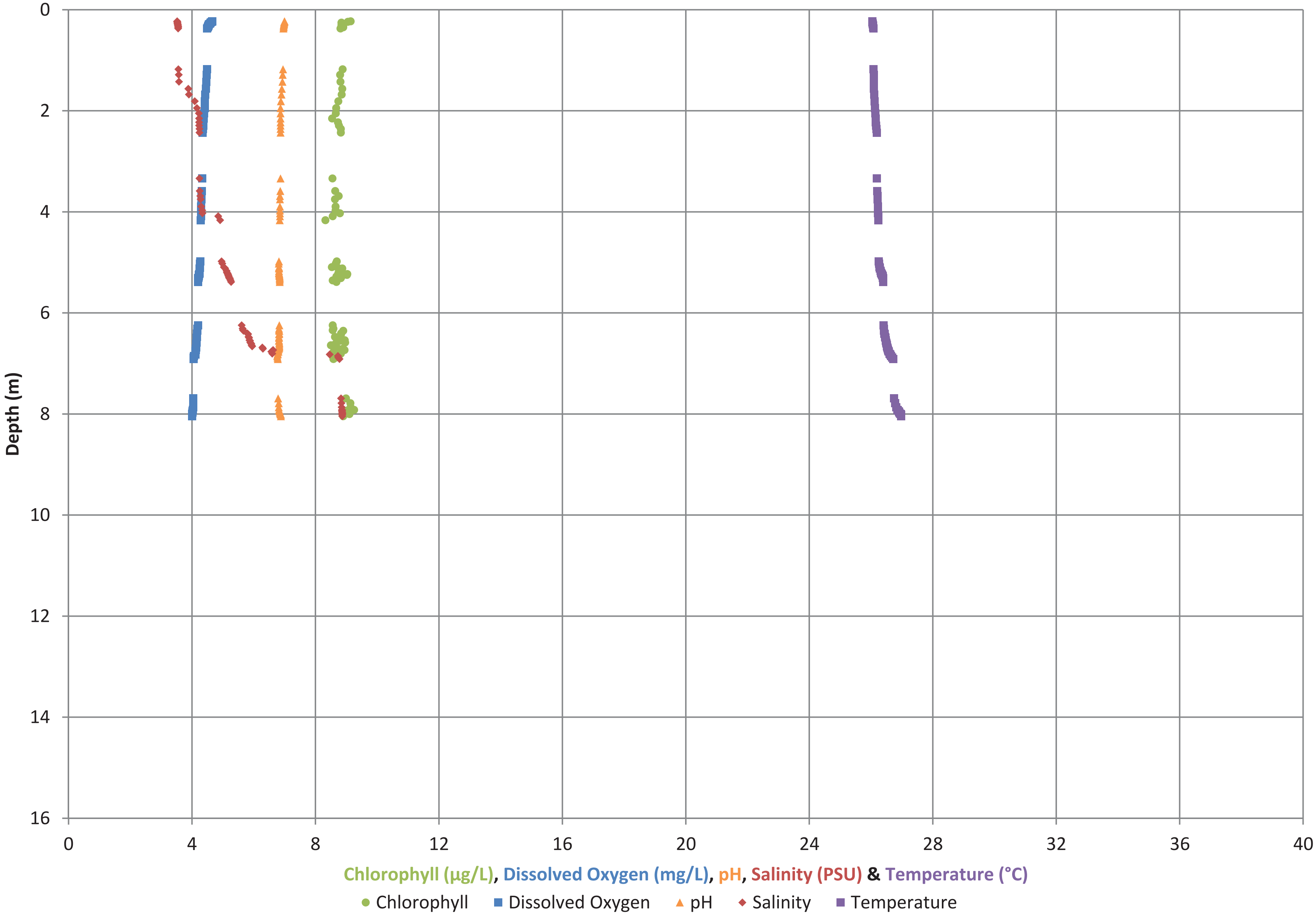
Location CFBW S



Date & Time 9/7/17 13:59

Cape Fear Water Quality Study

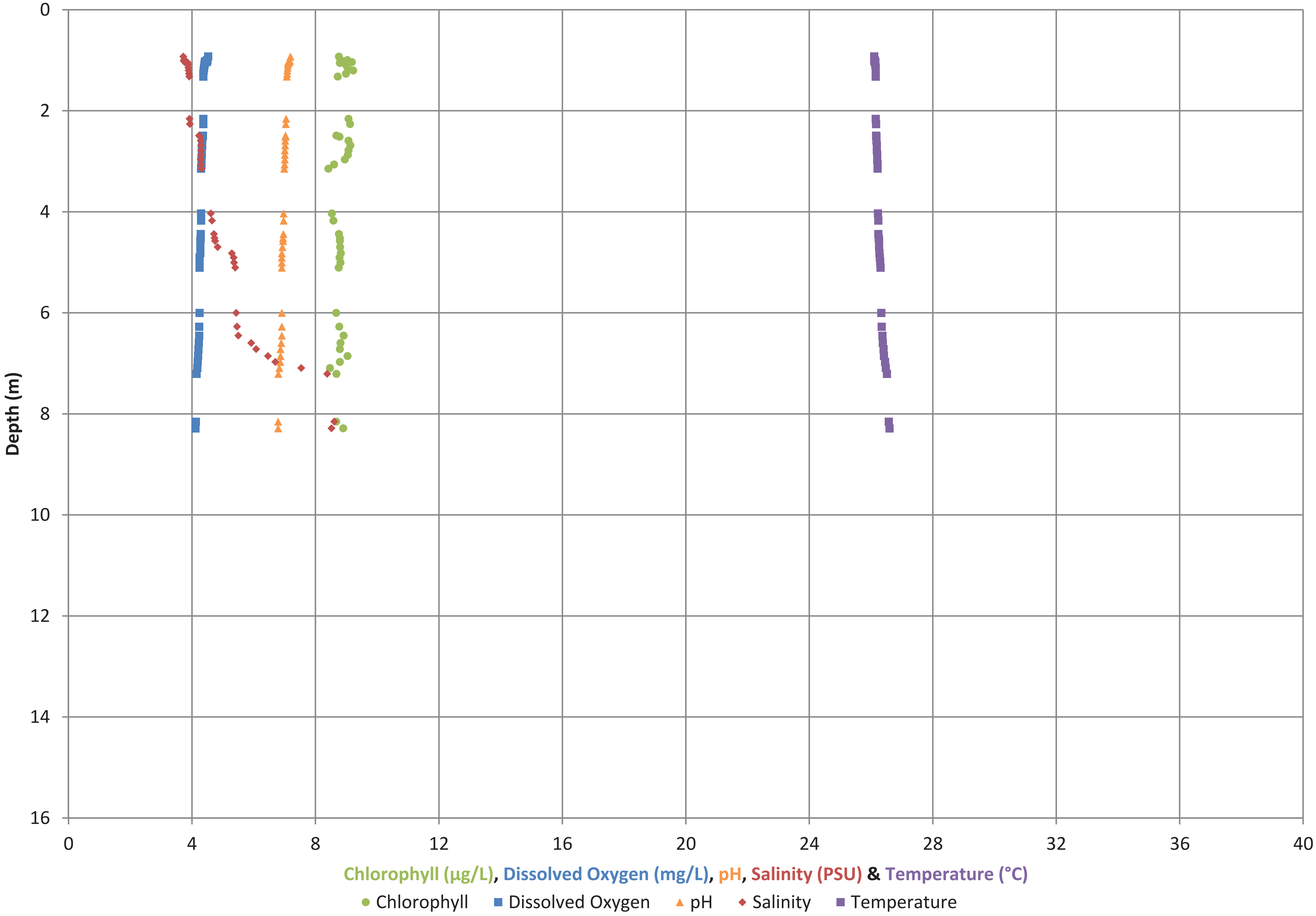
Location KM B



Date & Time 9/7/17 13:56

Cape Fear Water Quality Study

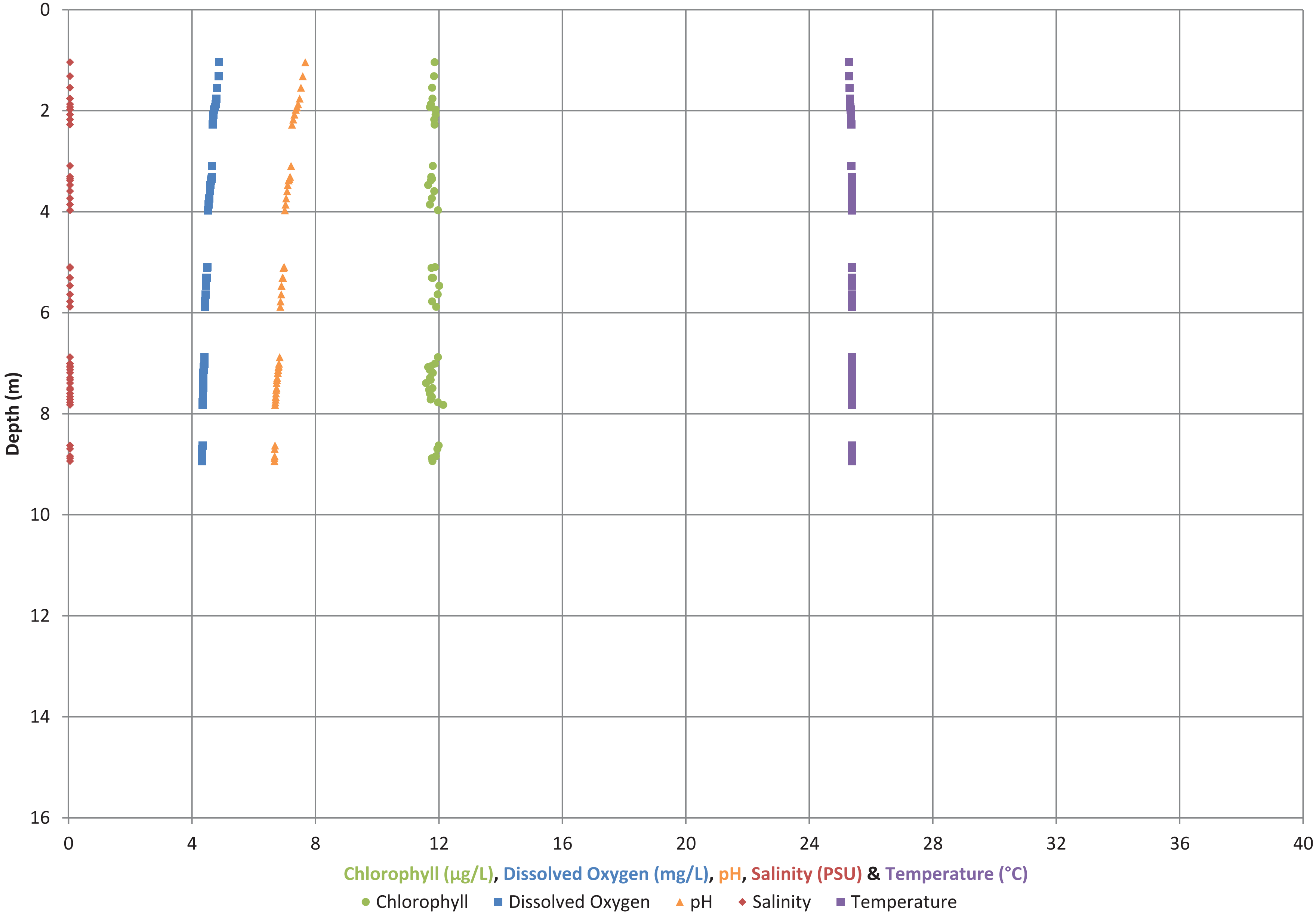
Location KM S



Date & Time 9/7/17 15:13

Cape Fear Water Quality Study

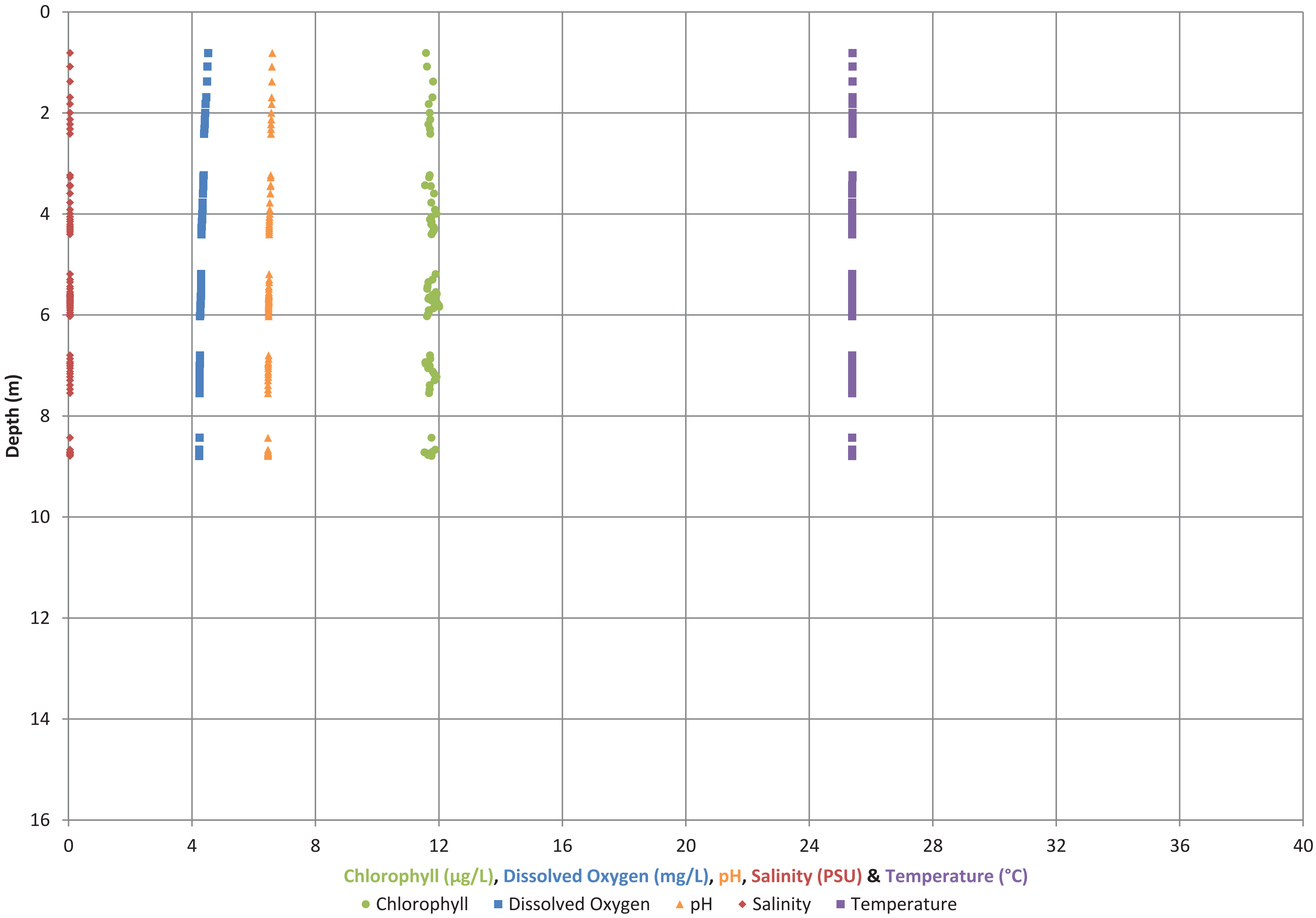
Location NECF 1



Date & Time 9/7/17 15:18

Cape Fear Water Quality Study

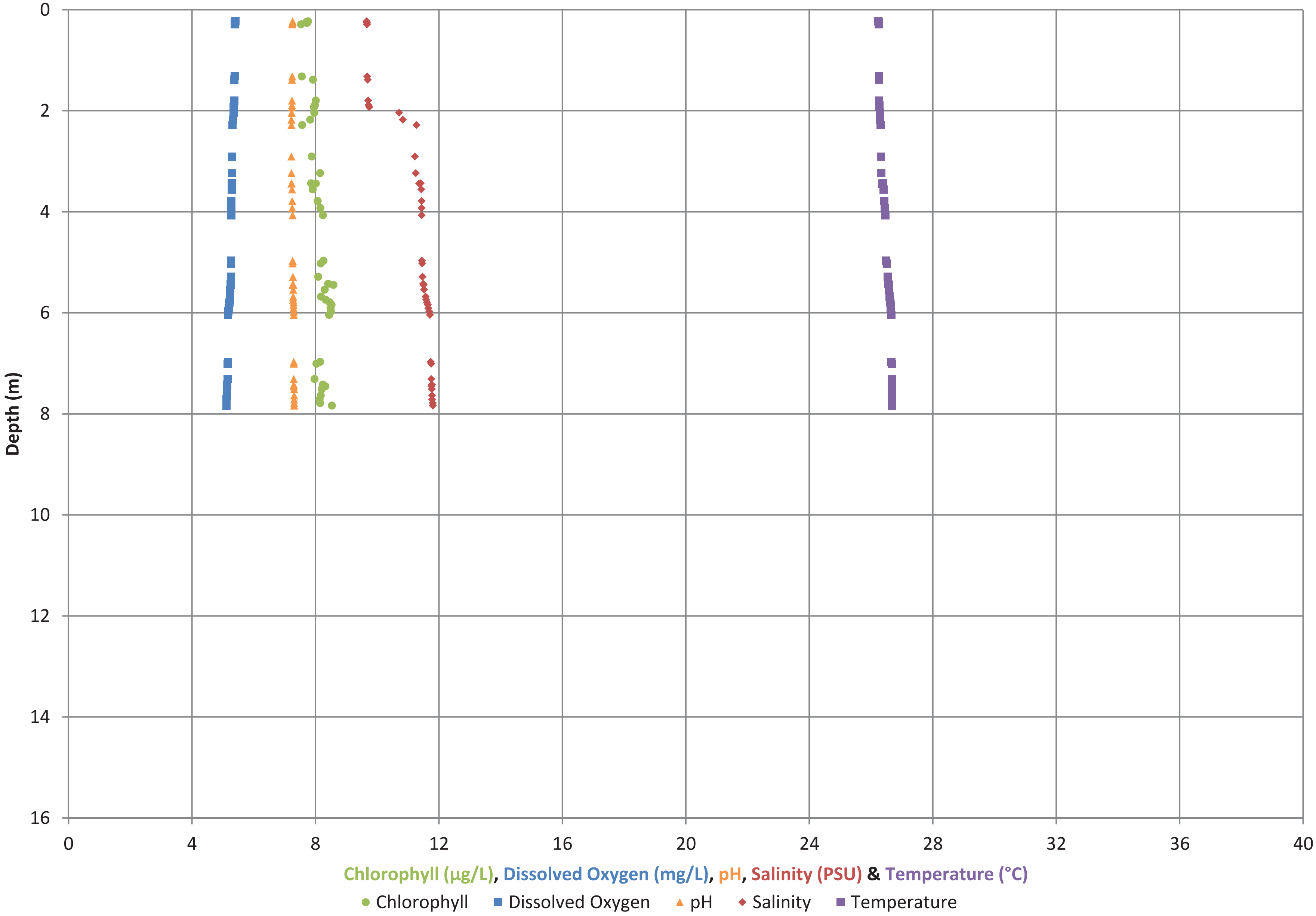
Location NECF 2

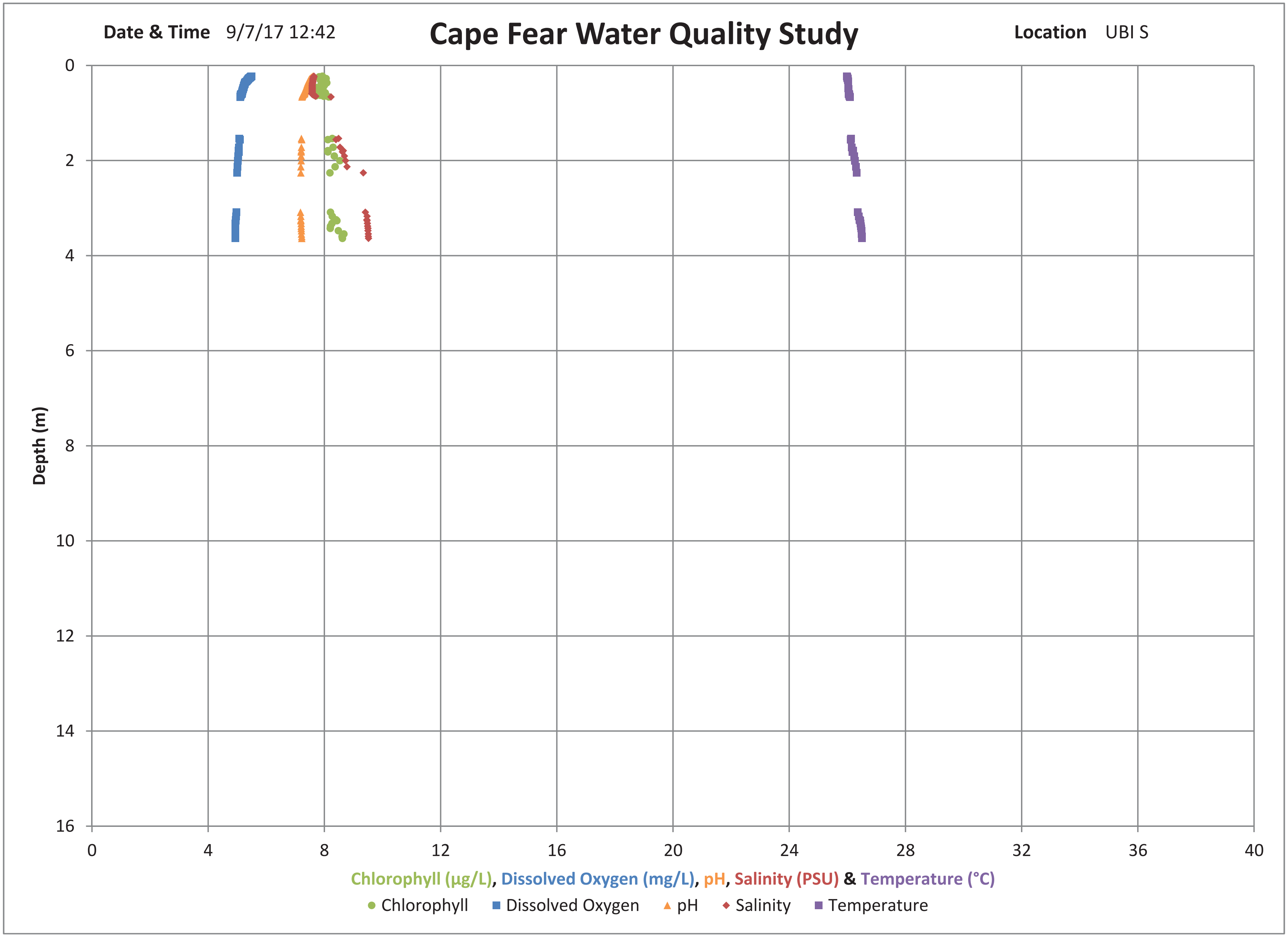


Date & Time 9/7/17 13:16

Cape Fear Water Quality Study

Location UBI B





Date & Time 9/7/17 12:42

Cape Fear Water Quality Study

Location UBI S

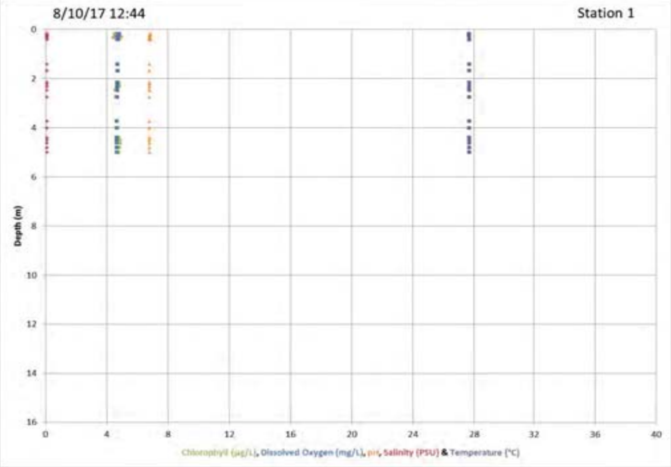
APPENDIX V Plots of CTD Data From Cast Taken Along Channel Centerline

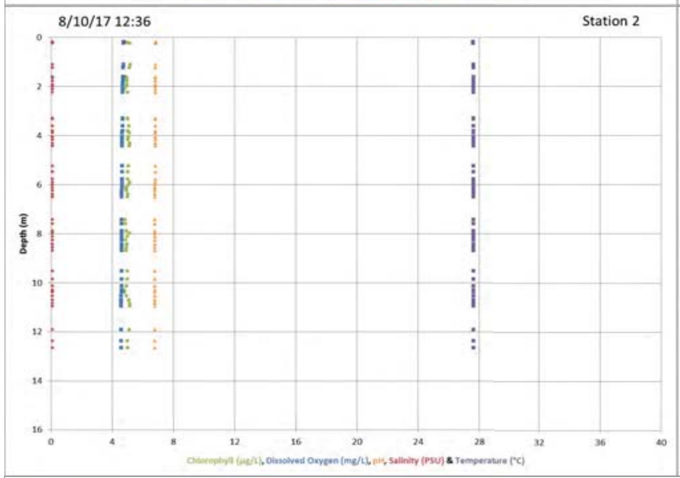
Cape Fear CTD Cast Data

Down Casts only

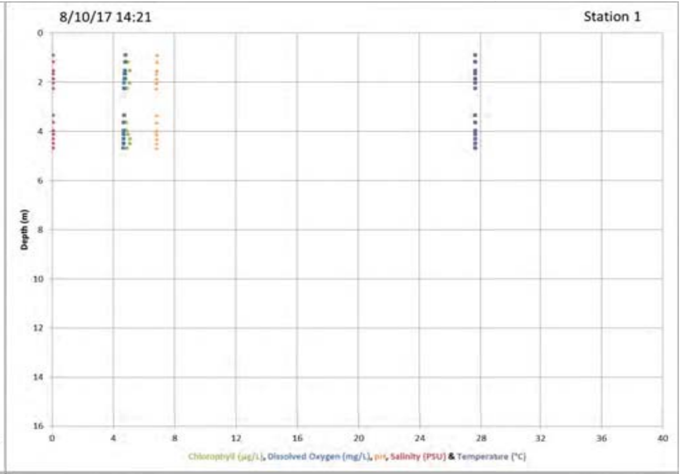
● Chlorophyll ■ Dissolved Oxygen ▲ pH ◆ Salinity ■ Temperature

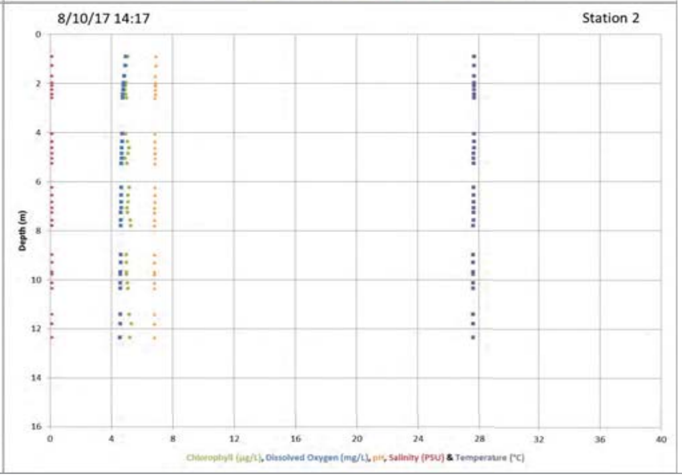
Round 1



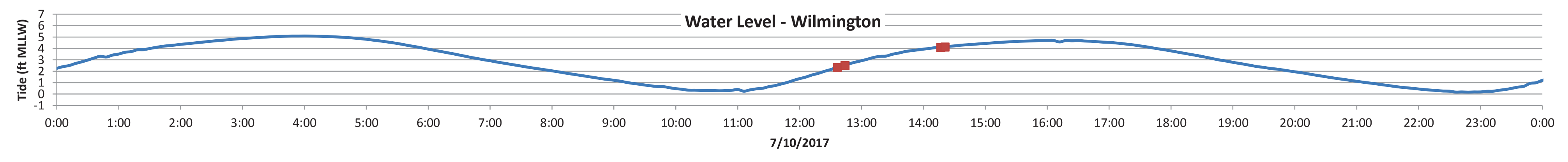


Round 2





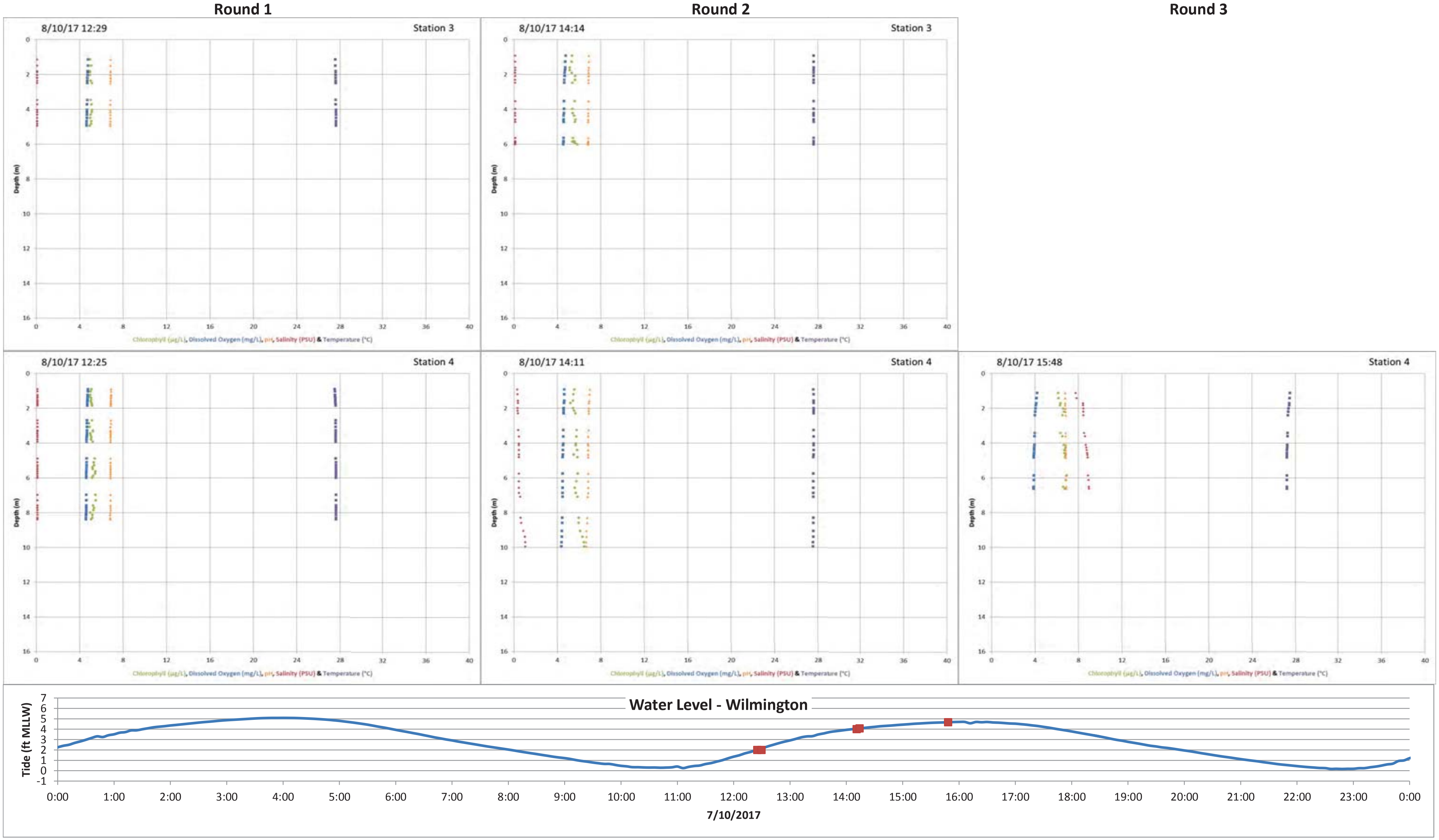
Round 3



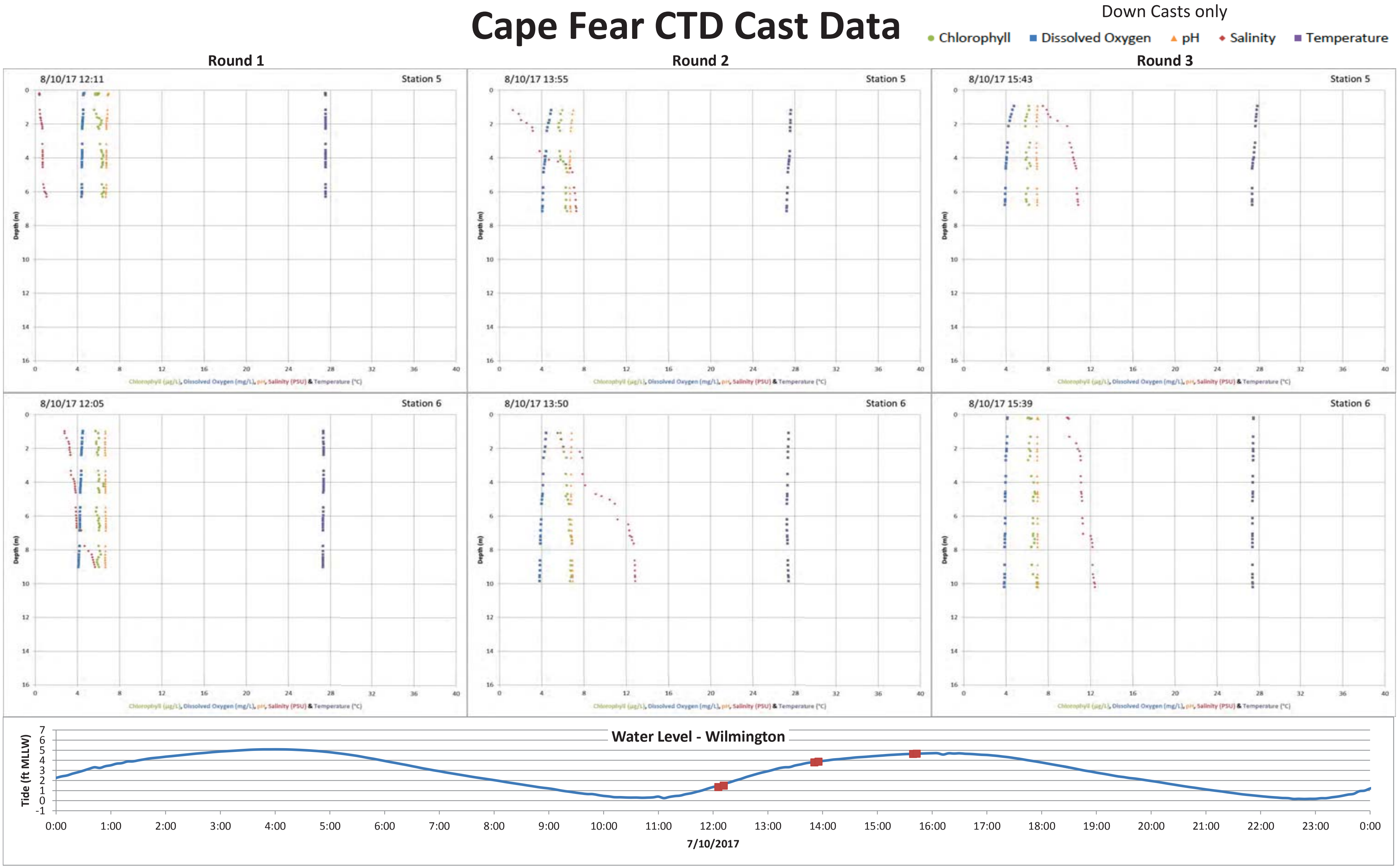
Cape Fear CTD Cast Data

Down Casts only

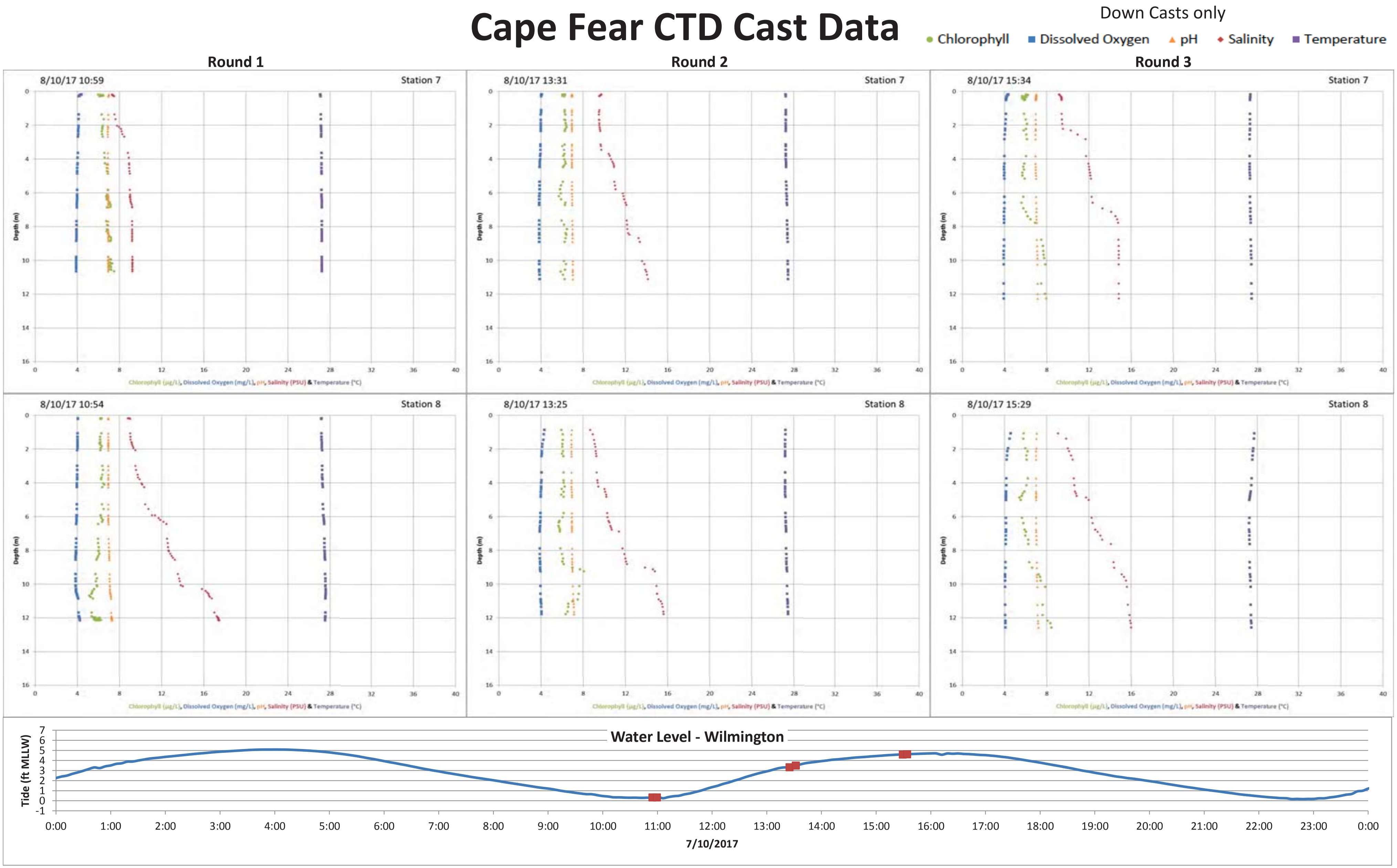
● Chlorophyll ■ Dissolved Oxygen ▲ pH ◆ Salinity ■ Temperature



Cape Fear CTD Cast Data



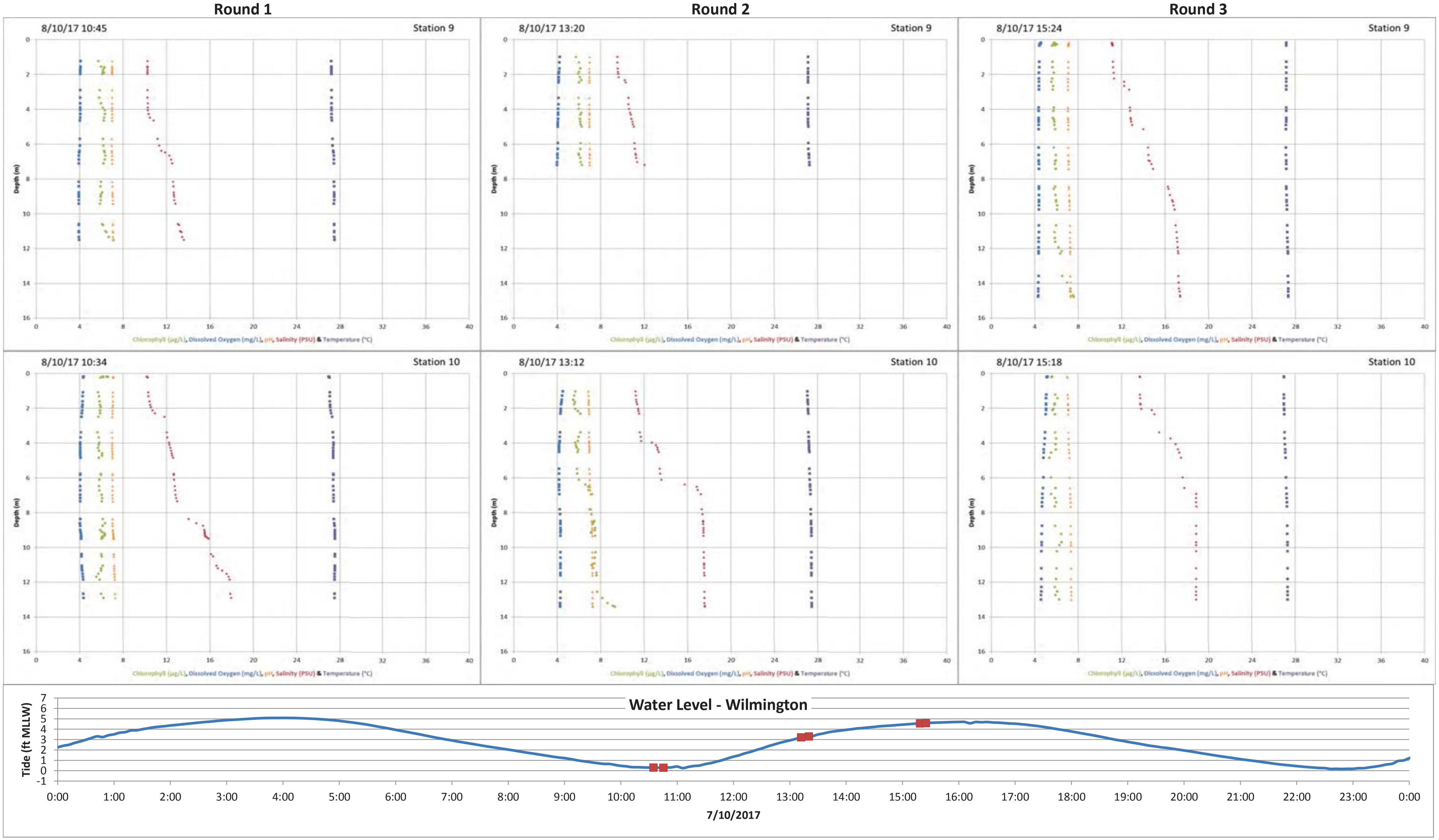
Cape Fear CTD Cast Data



Cape Fear CTD Cast Data

Down Casts only

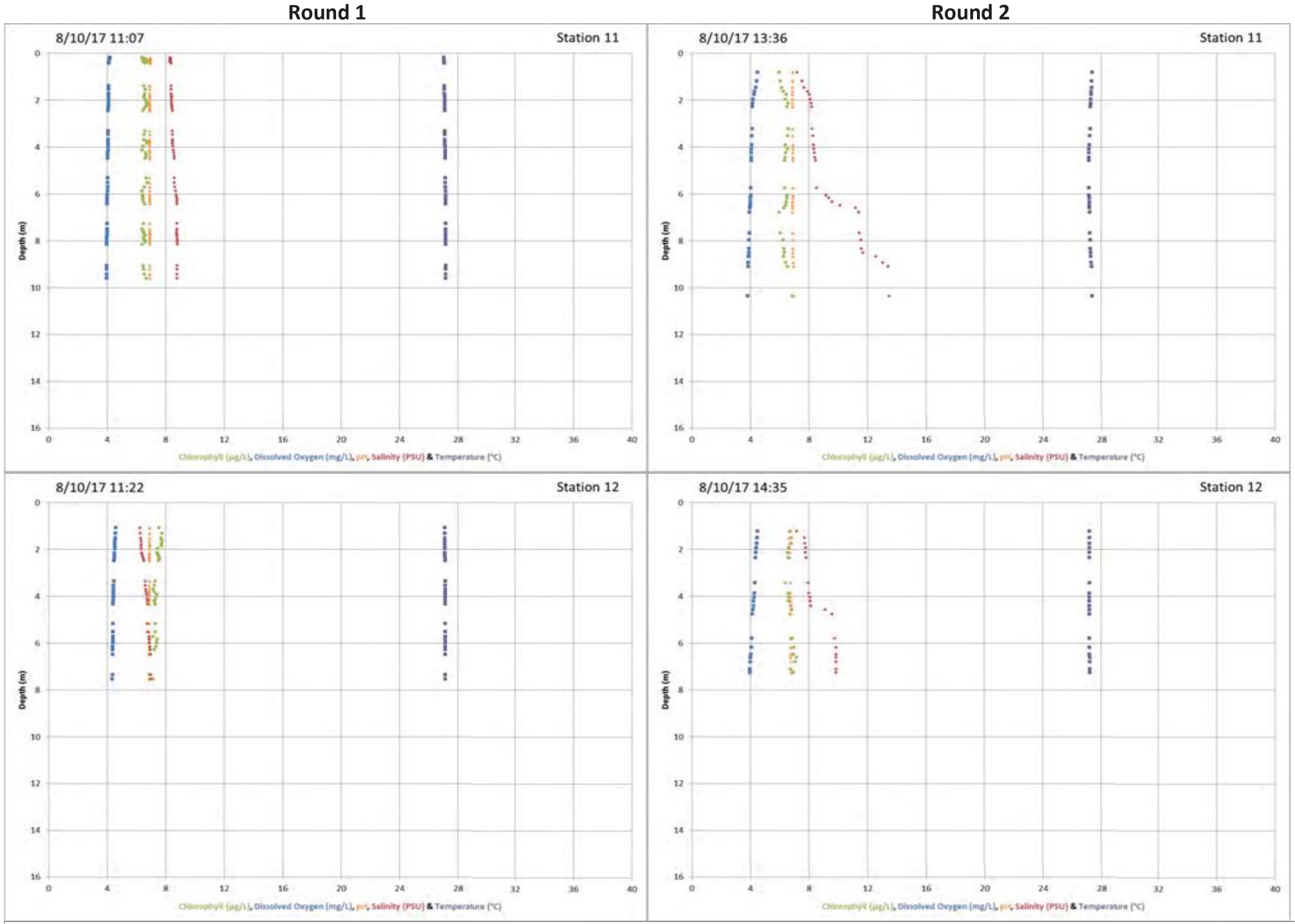
● Chlorophyll ■ Dissolved Oxygen ▲ pH ◆ Salinity ■ Temperature

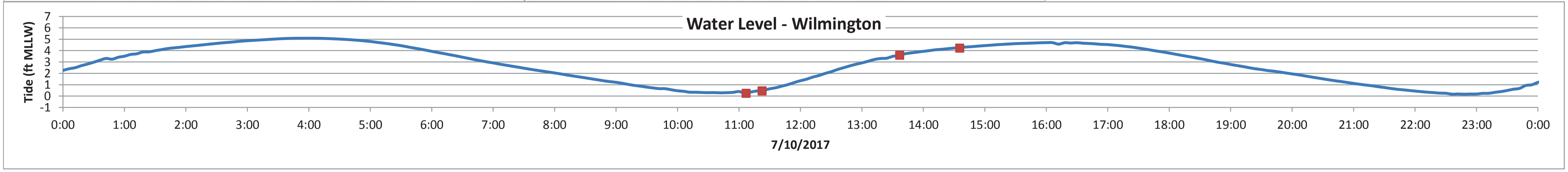


Cape Fear CTD Cast Data

Down Casts only

● Chlorophyll ■ Dissolved Oxygen ▲ pH ◆ Salinity ■ Temperature



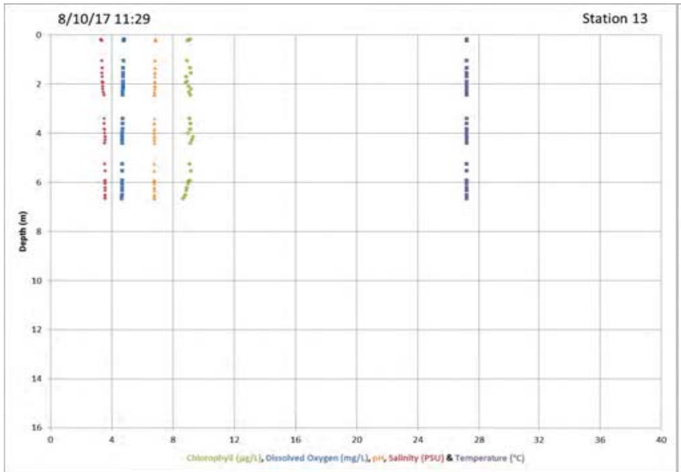


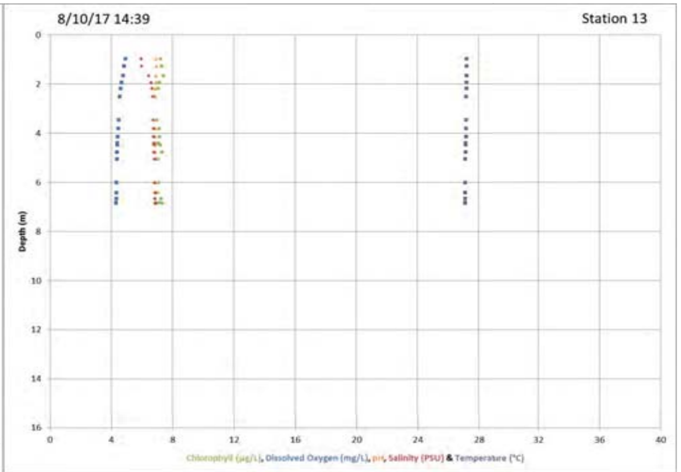
Cape Fear CTD Cast Data

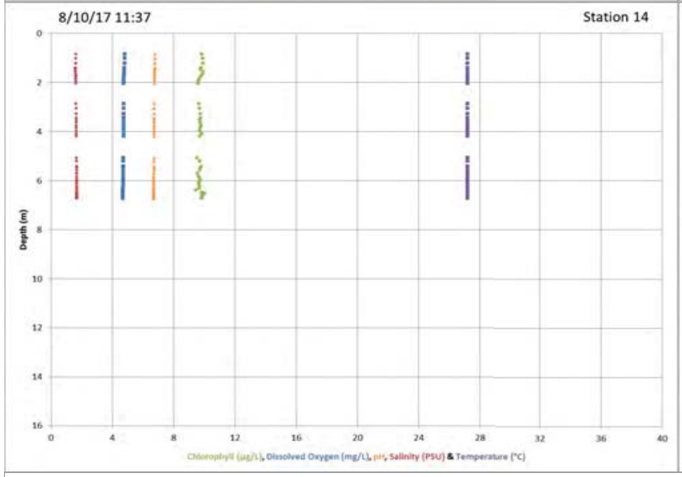
Down Casts only

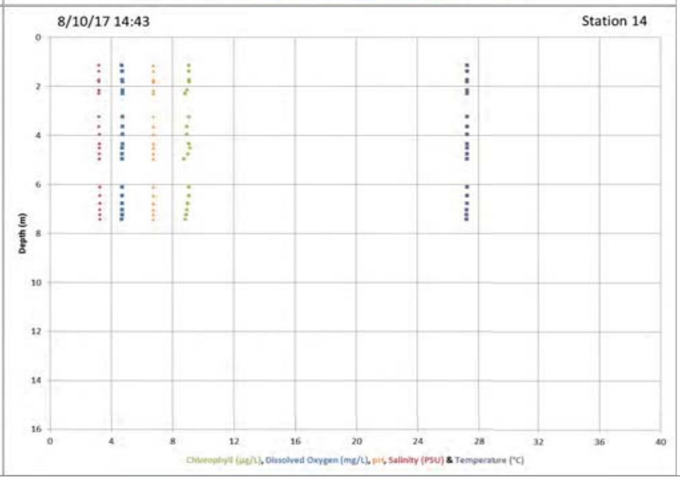
● Chlorophyll ■ Dissolved Oxygen ▲ pH ◆ Salinity ■ Temperature

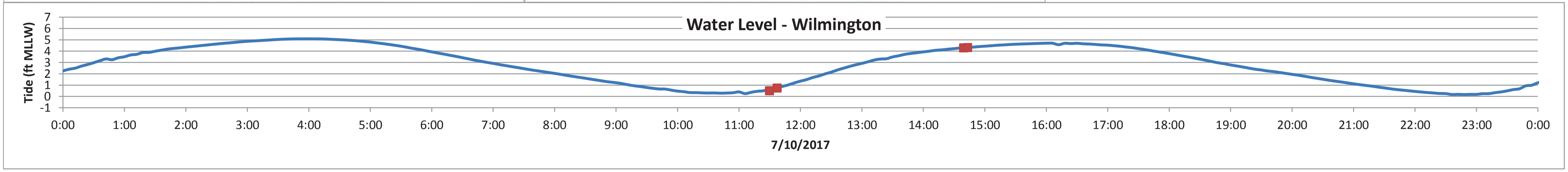
Round 1 **Round 2** **Round 3**









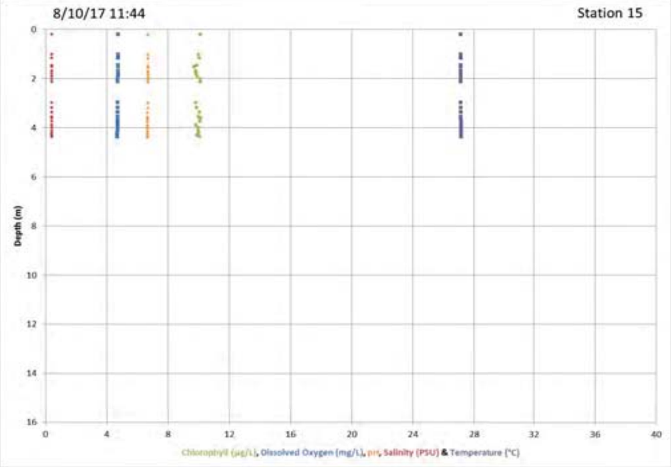


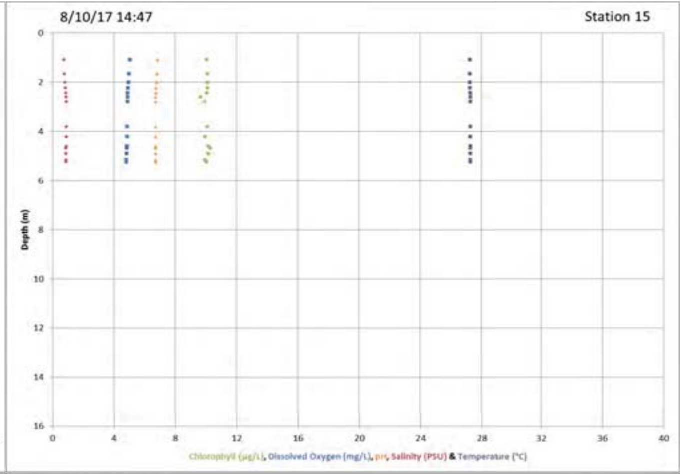
Cape Fear CTD Cast Data

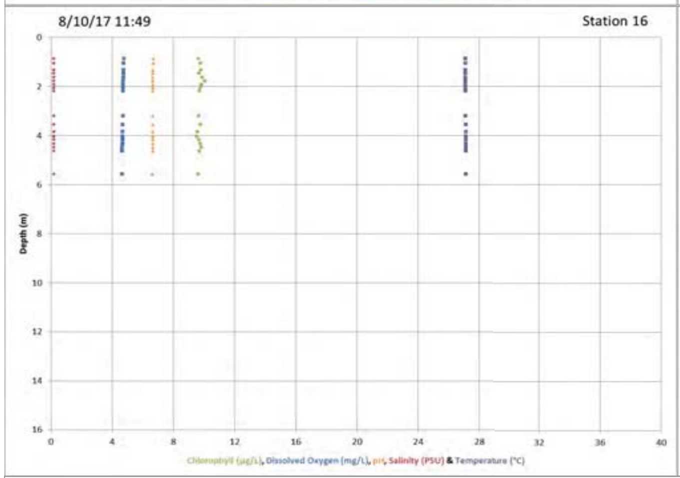
Down Casts only

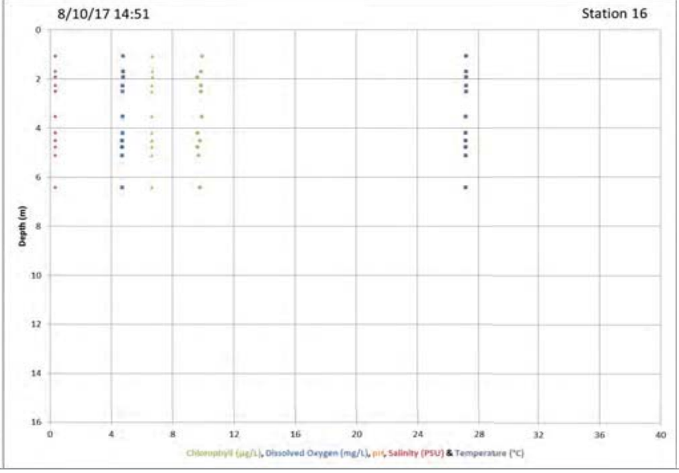
● Chlorophyll ■ Dissolved Oxygen ▲ pH ◆ Salinity ■ Temperature

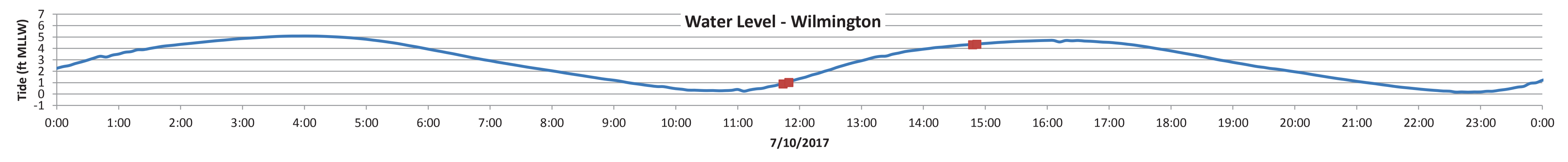
Round 1 **Round 2** **Round 3**











Appendix B–1:
Channel Figures

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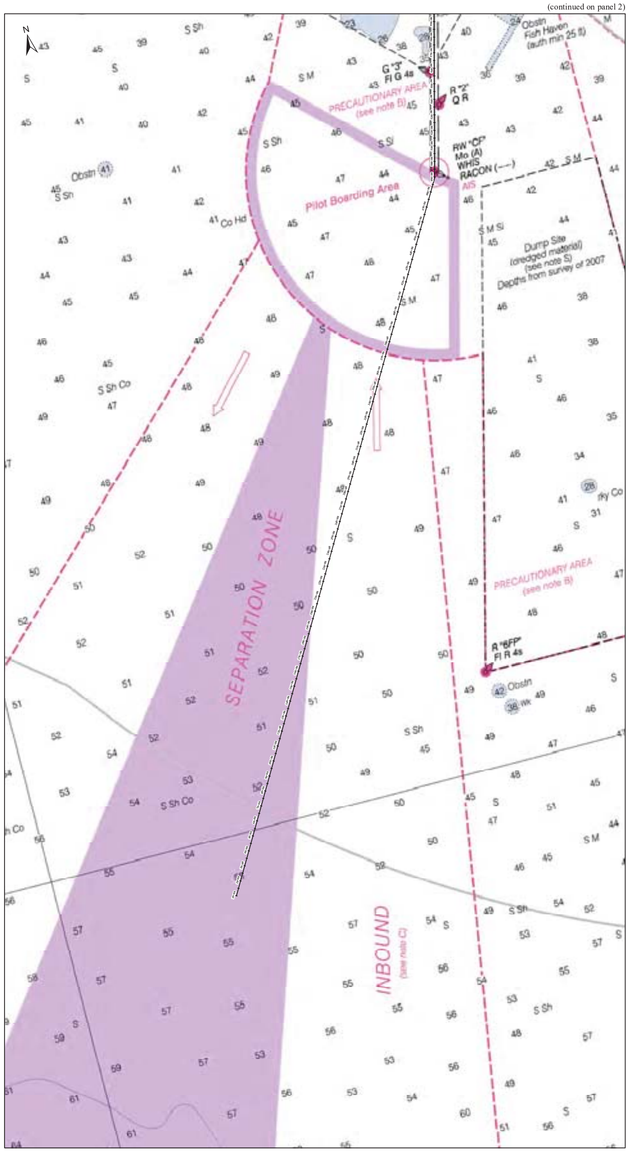
(continued on panel 2)



Existing Navigation Channel with Stationing

Scale for Panel 1 - 1:48,000

0 4,000 8,000 12,000 16,000 20,000 Feet

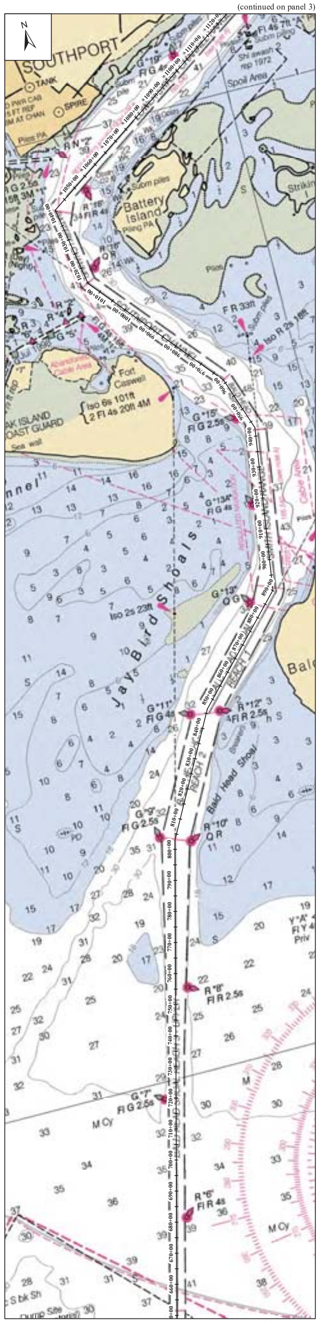
0 2,000 4,000 6,000 8,000 10,000 Feet

Scale for Panels 2-5 - 1:24,000

Notes:
Chart Source - NOAA Raster Nautical Charts (RNCs) 11536 & 11537
The direction of true north has been rotated counterclockwise by 14°, 14°, & 43°, for panels 1, 2, & 3, respectively.

Scaling assumes print size of 34" x 22"

(continued on panel 3)



(continued from panel 1)

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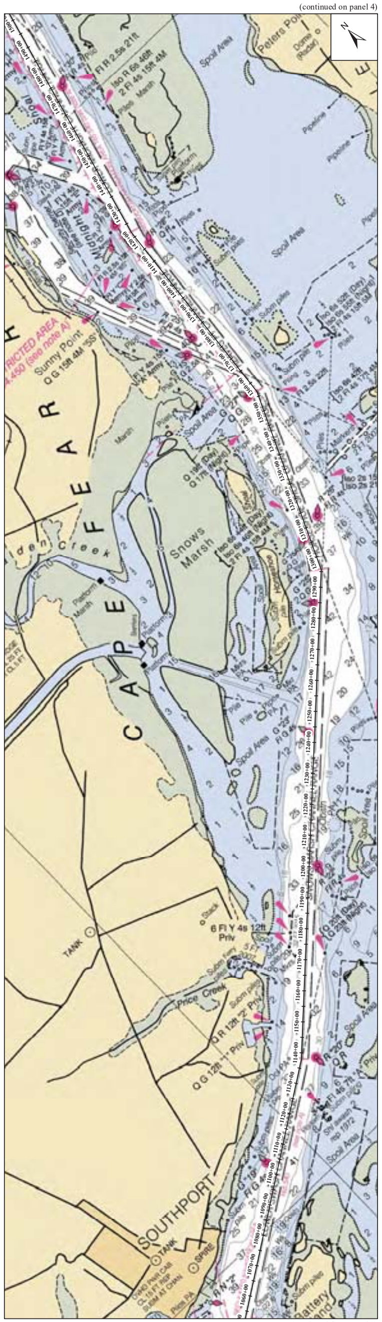

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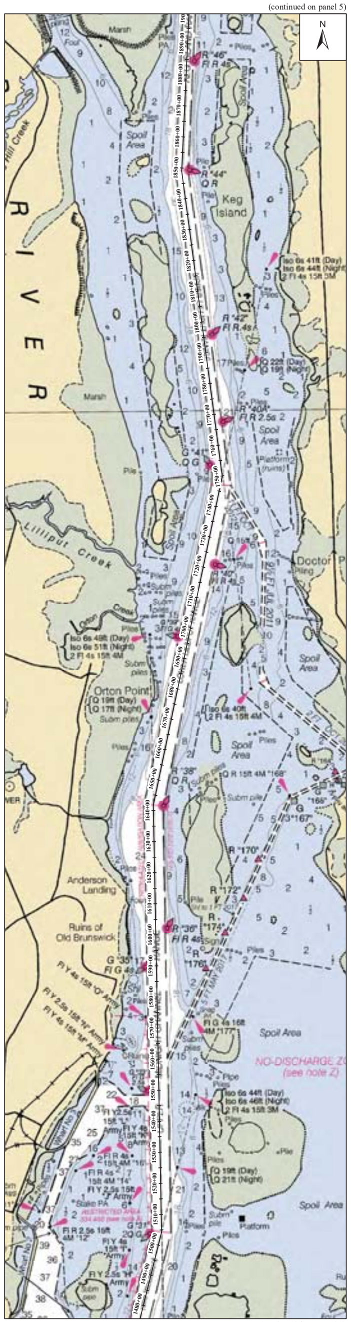
(continued on panel 5)



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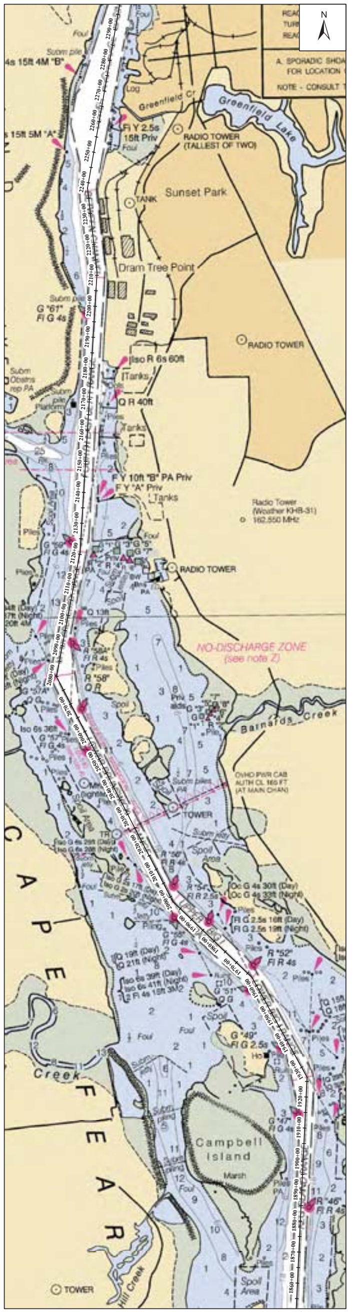

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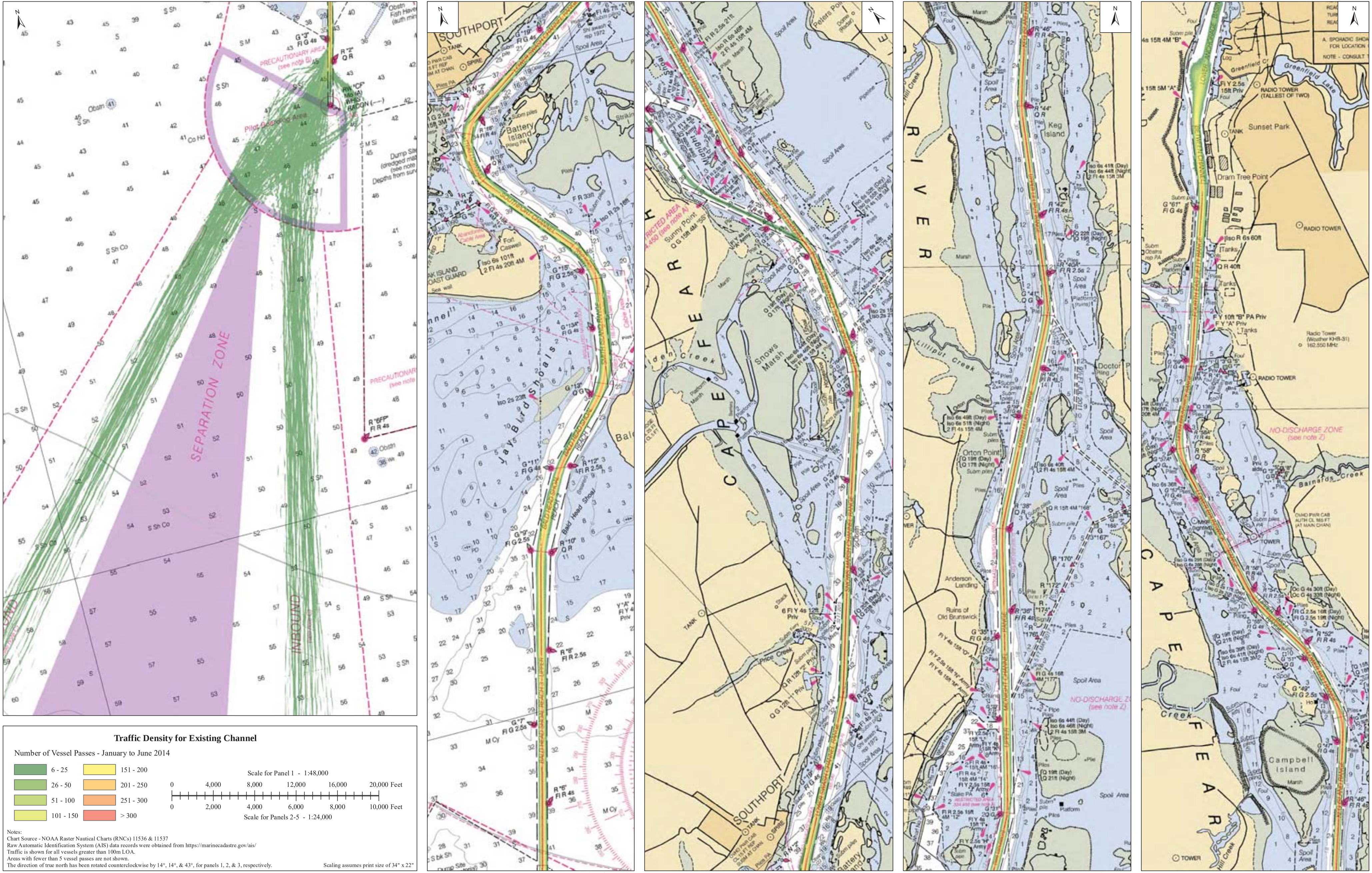
(continued on panel 2)

(continued on panel 3)

(continued on panel 4)

(continued on panel 5)



(continued from panel 1)

(continued from panel 2)

(continued from panel 3)

(continued from panel 4)

Traffic Density for Existing Channel

Number of Vessel Passes - January to June 2014

🟩	6 - 25	🟨	151 - 200
🟩	26 - 50	🟧	201 - 250
🟩	51 - 100	🟧	251 - 300
🟨	101 - 150	🟥	> 300

Scale for Panel 1 - 1:48,000

0 4,000 8,000 12,000 16,000 20,000 Feet

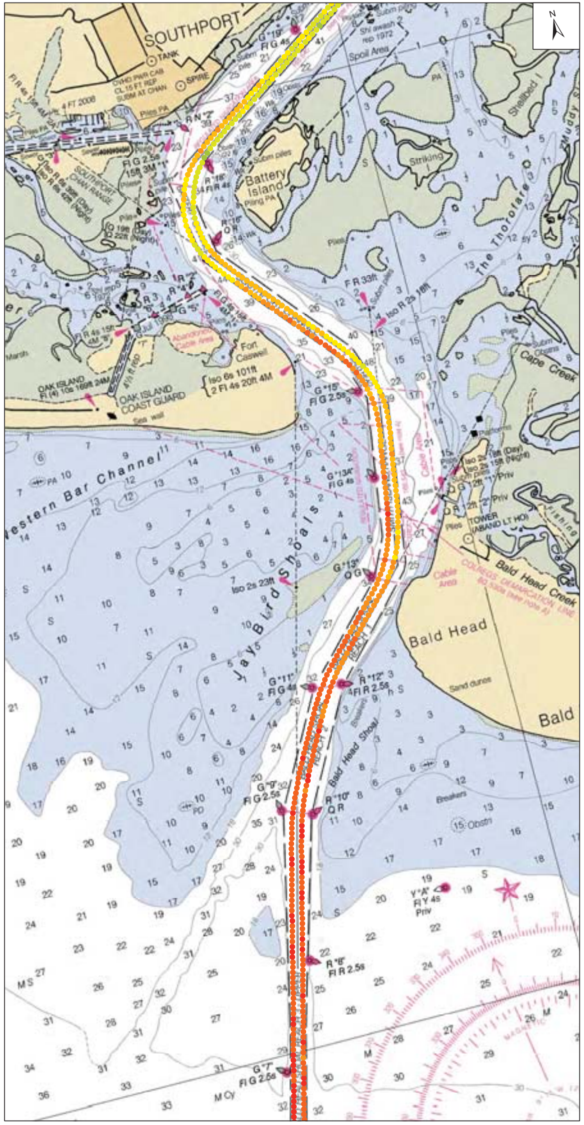
0 2,000 4,000 6,000 8,000 10,000 Feet

Scale for Panels 2-5 - 1:24,000

Notes:
Chart Source - NOAA Raster Nautical Charts (RNCs) 11536 & 11537
Raw Automatic Identification System (AIS) data records were obtained from https://marinecadastre.gov/ais/
Traffic is shown for all vessels greater than 100m LOA.
Areas with fewer than 5 vessel passes are not shown.
The direction of true north has been rotated counterclockwise by 14°, 14°, & 43°, for panels 1, 2, & 3, respectively.

Scaling assumes print size of 34" x 22"

(continued on panel 2)



Typical Transit Speeds

Vessel Speed (knots)

- ● < 8.5
- ● 8.6 - 9.0
- ● 9.1 - 9.5
- ● 9.6 - 10.0
- ● 10.1 - 10.5
- ● 10.6 - 11.0
- ● 11.1 - 11.5
- ● 11.6 - 12.0
- ● 12.1 - 12.5
- ● 12.6 - 13.0

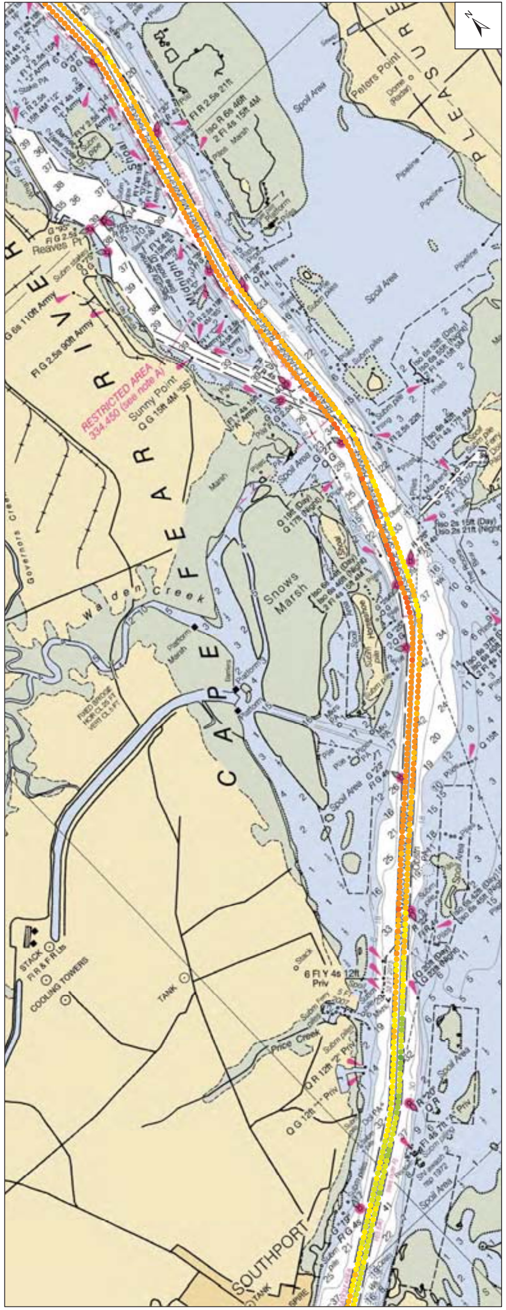
0 2,000 4,000 6,000 8,000 10,000 Feet

Notes:
Upbound traffic speeds are shown on the right and downbound speeds on the left.
Chart Source - NOAA Raster Nautical Charts (RNCs) 11536 & 11537
The direction of true north has been rotated counterclockwise by 14° & 43°, for panels 1 & 2, respectively.

1 inch = 2,000 feet

Scaling assumes print size of 34" x 22"

(continued on panel 3)



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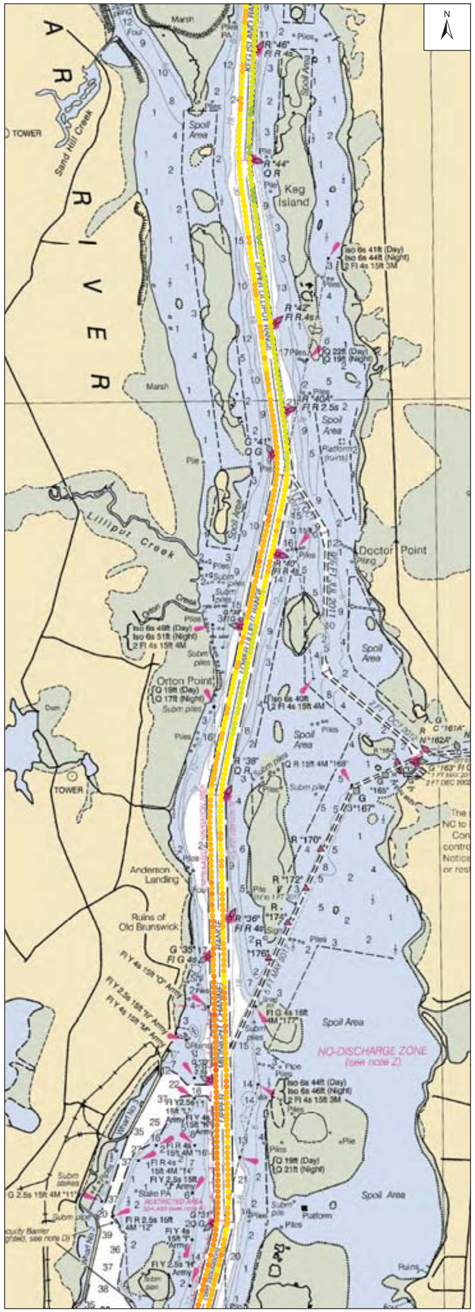
(continued on panel 4)



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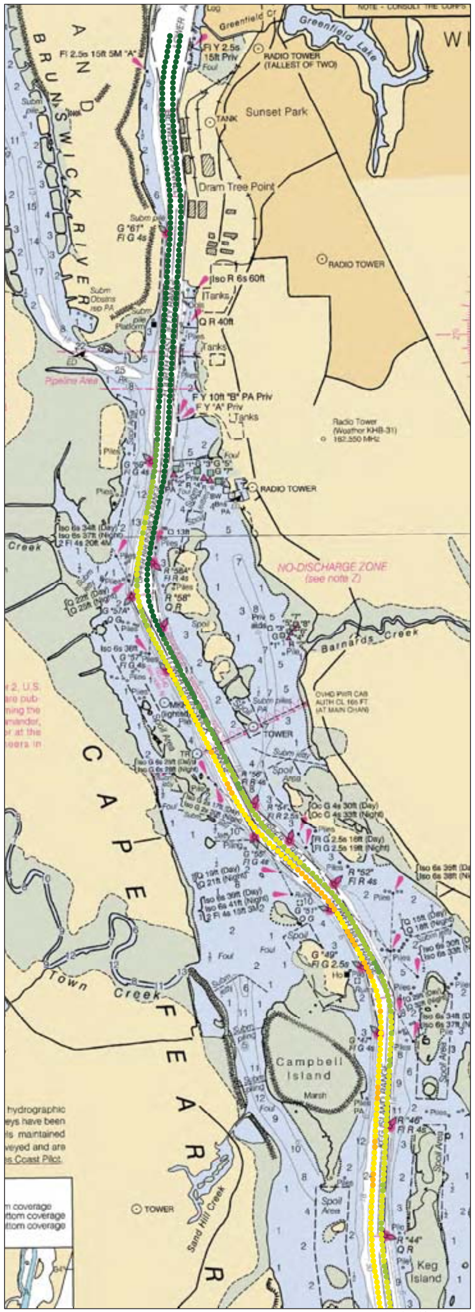

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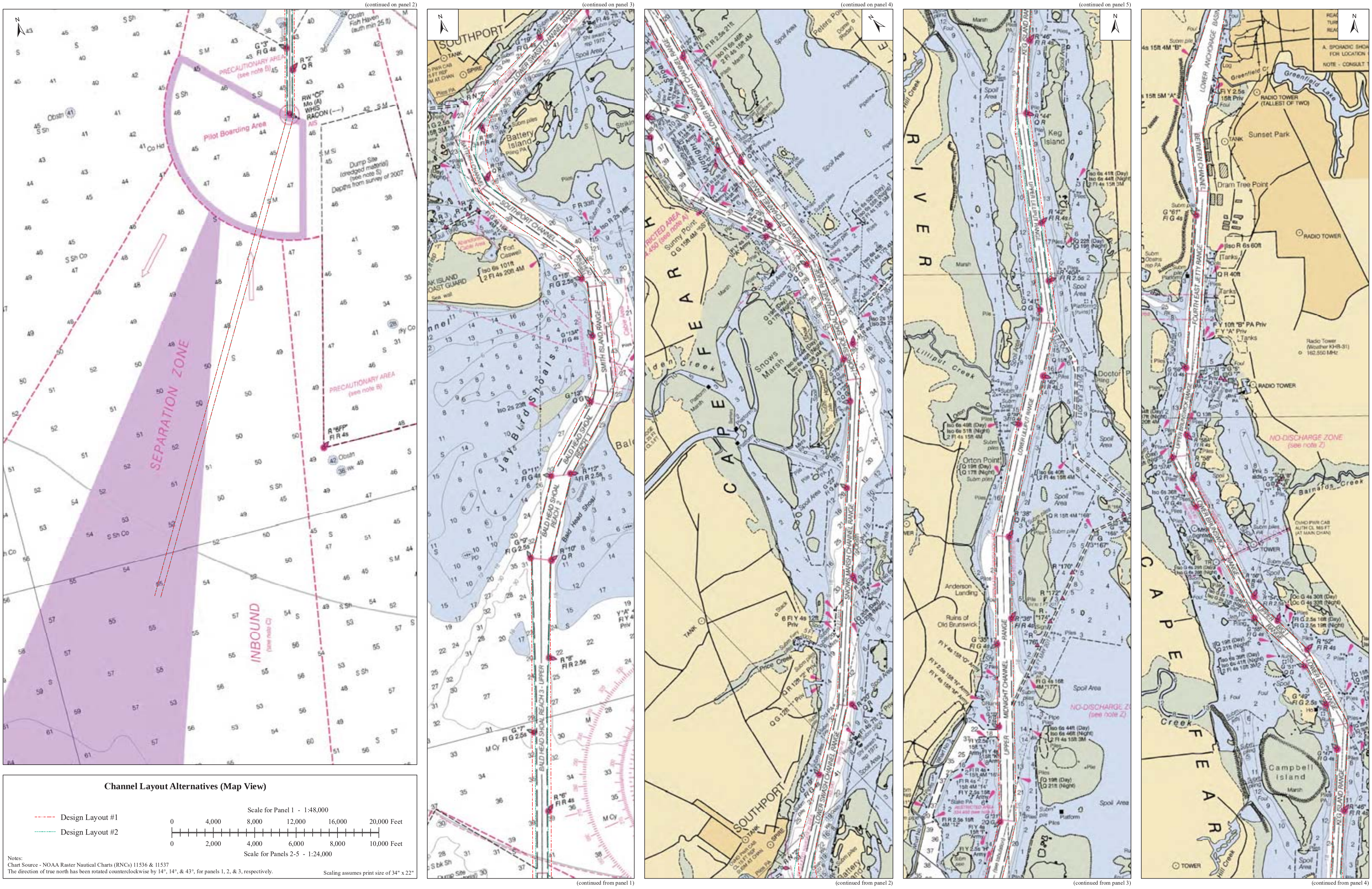


Channel Layout Alternatives (Map View)

- · - · -	Design Layout #1
······	Design Layout #2

Scale for Panel 1 - 1:48,000

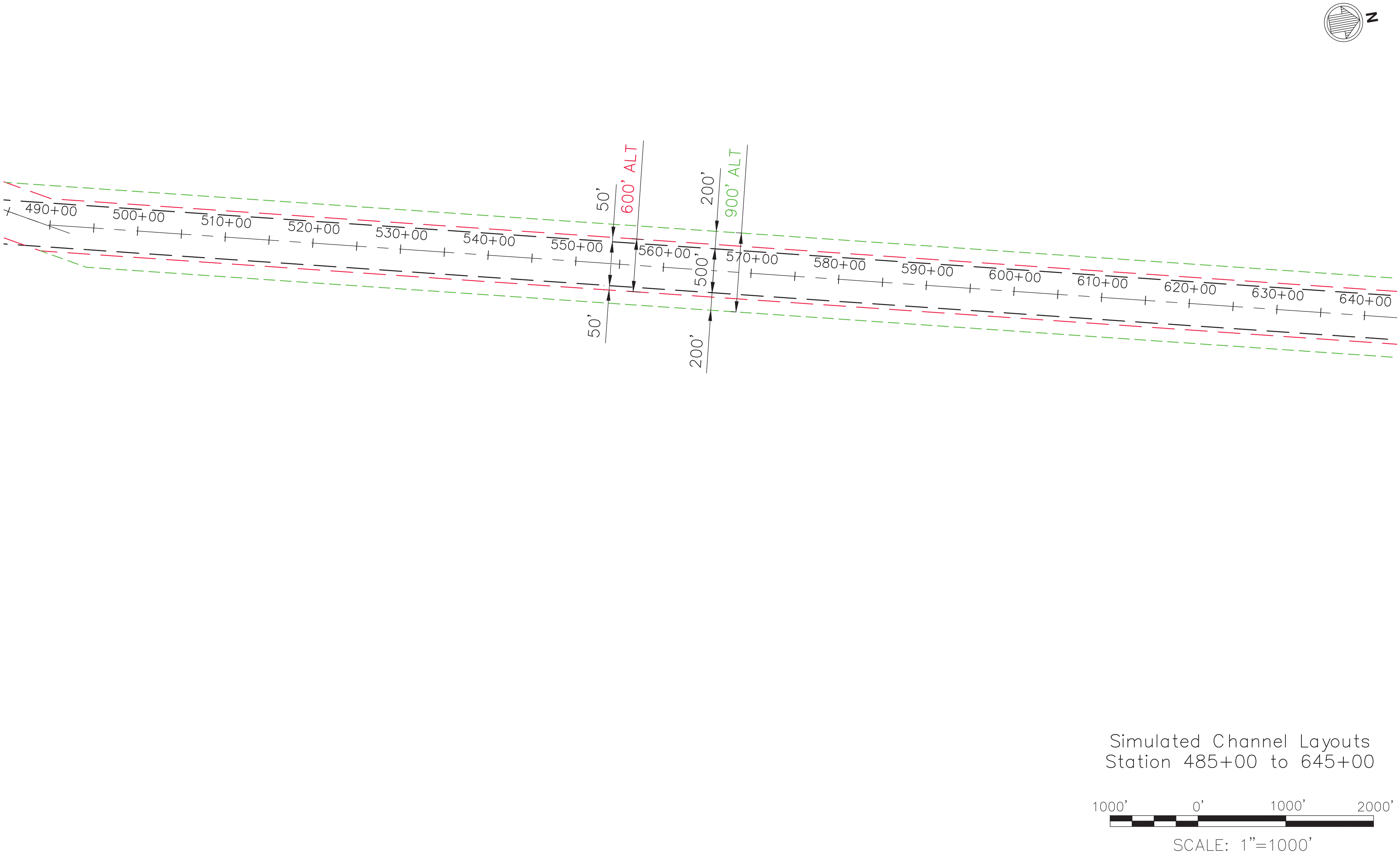
0 4,000 8,000 12,000 16,000 20,000 Feet

0 2,000 4,000 6,000 8,000 10,000 Feet

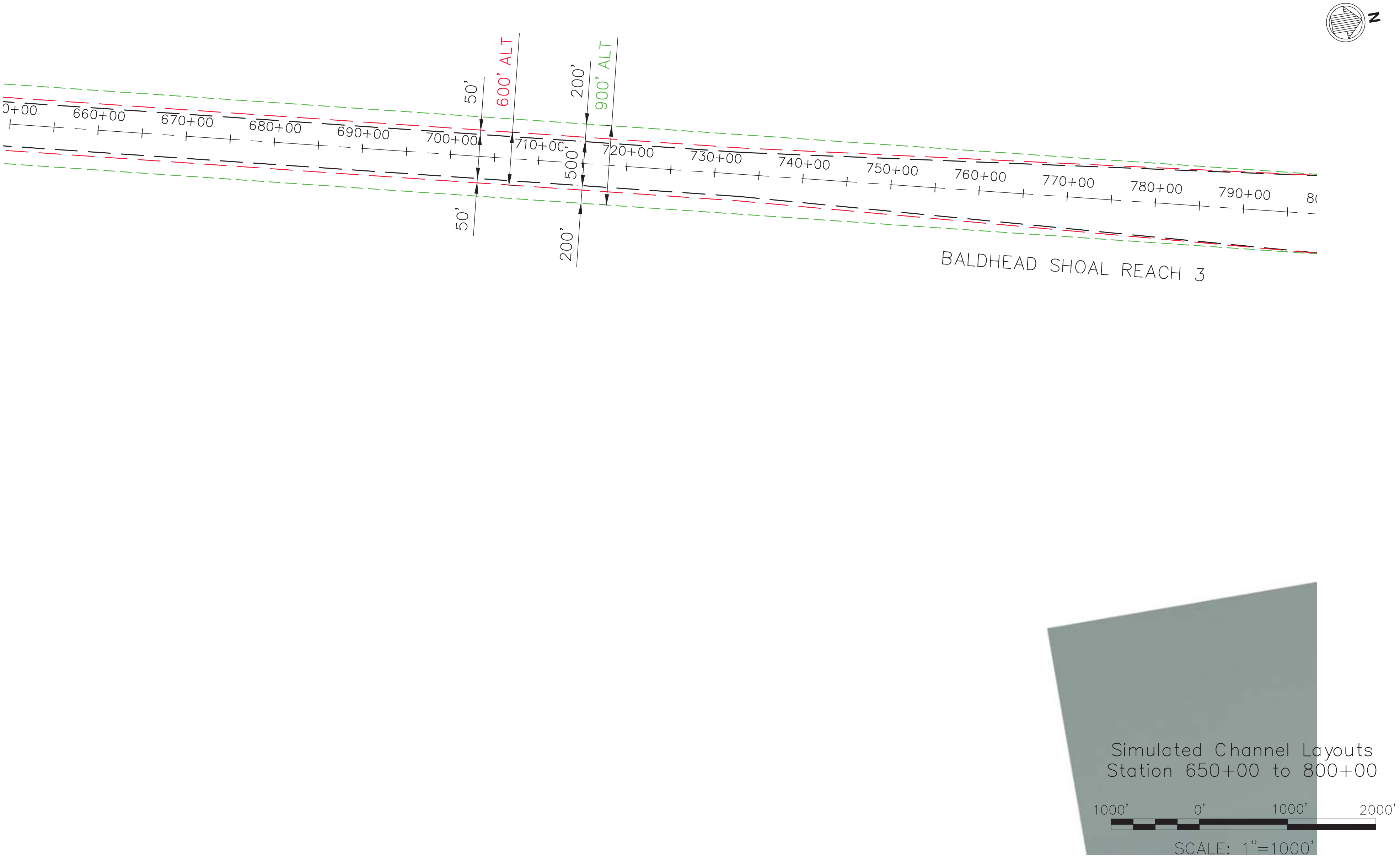
Scale for Panels 2-5 - 1:24,000

Notes:
Chart Source - NOAA Raster Nautical Charts (RNCs) 11536 & 11537
The direction of true north has been rotated counterclockwise by 14°, 14°, & 43°, for panels 1, 2, & 3, respectively.

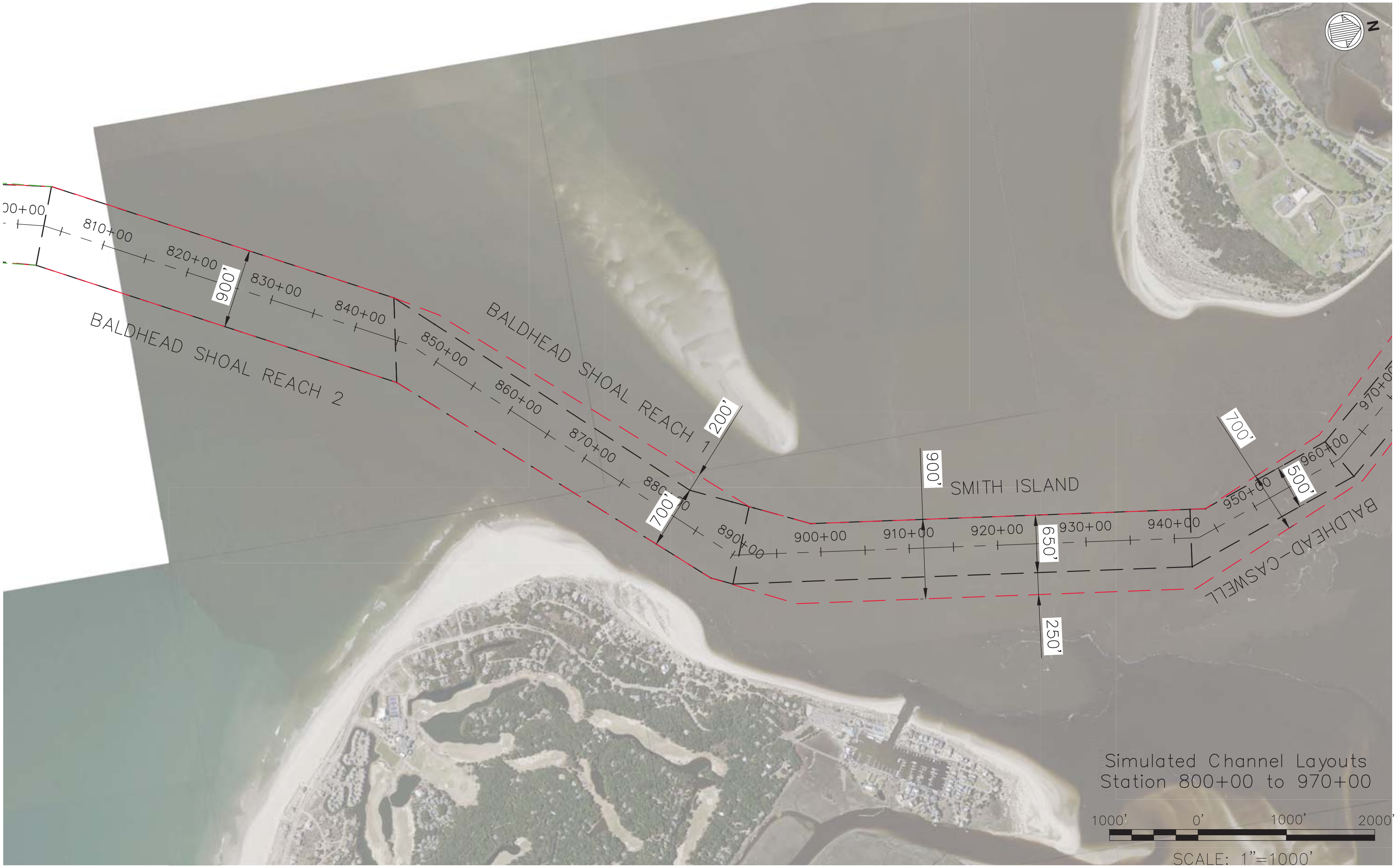
Scaling assumes print size of 34" x 22"



Simulated Channel Layouts
Station 485+00 to 645+00

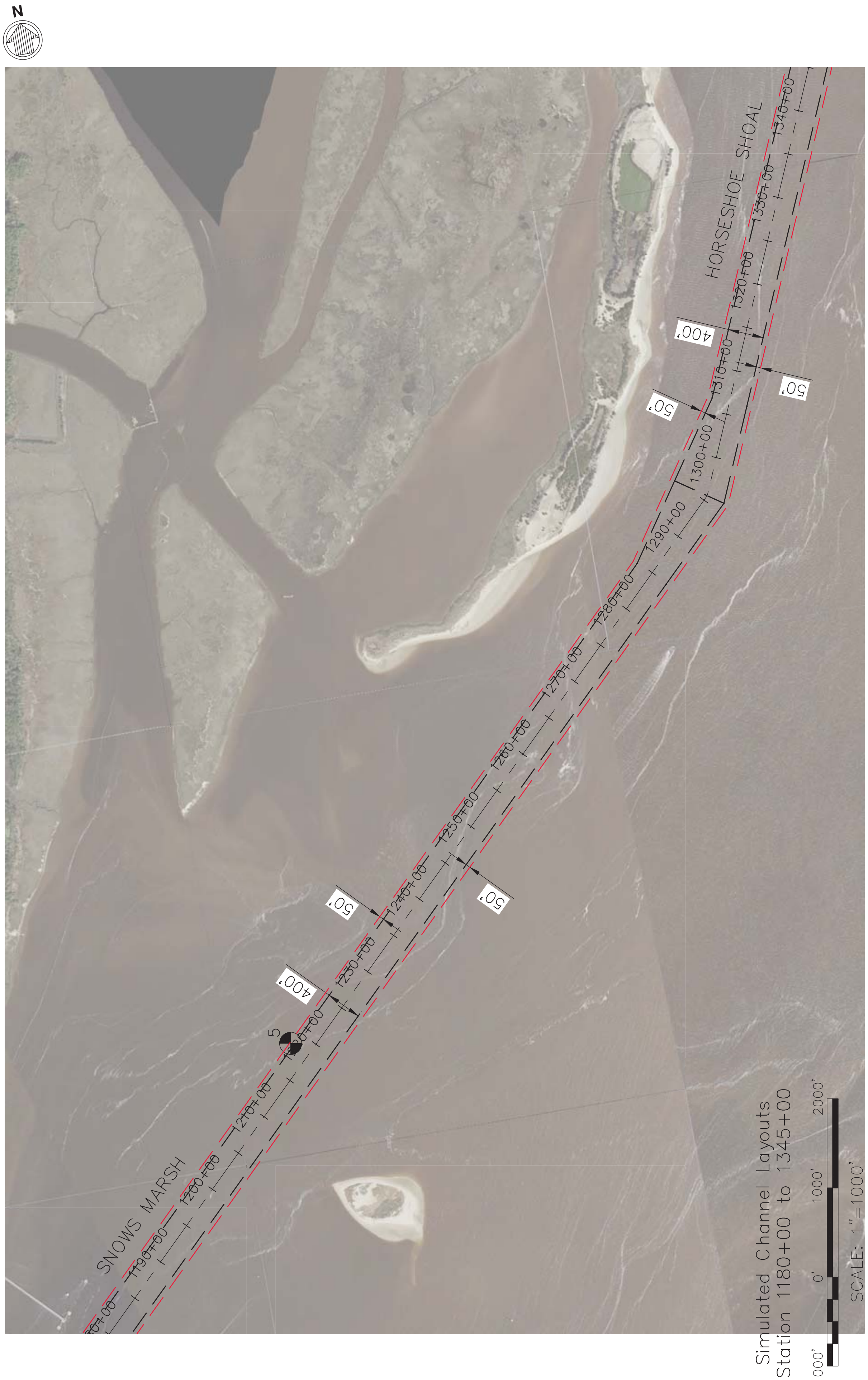


Simulated Channel Layouts
Station 650+00 to 800+00



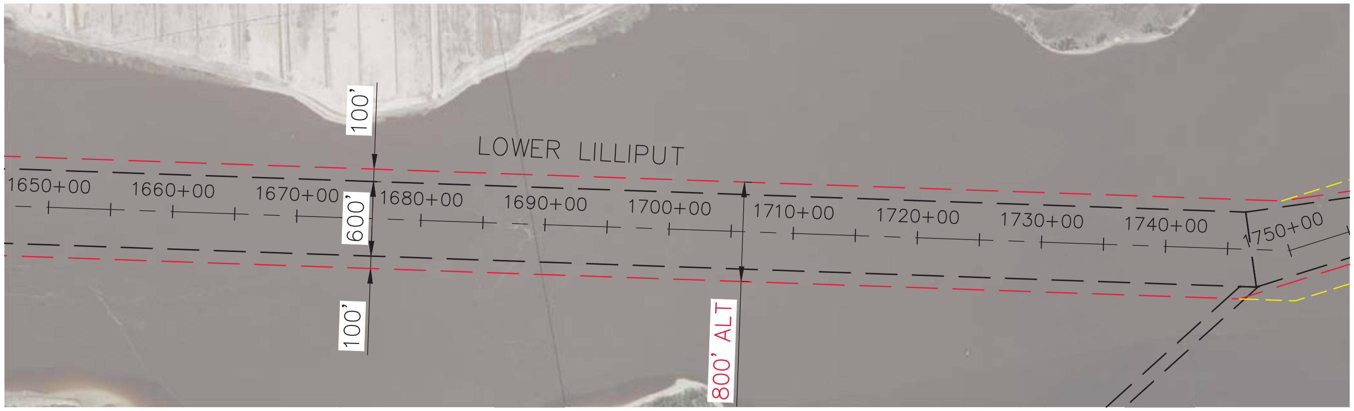
Simulated Channel Layouts
Station 800+00 to 970+00

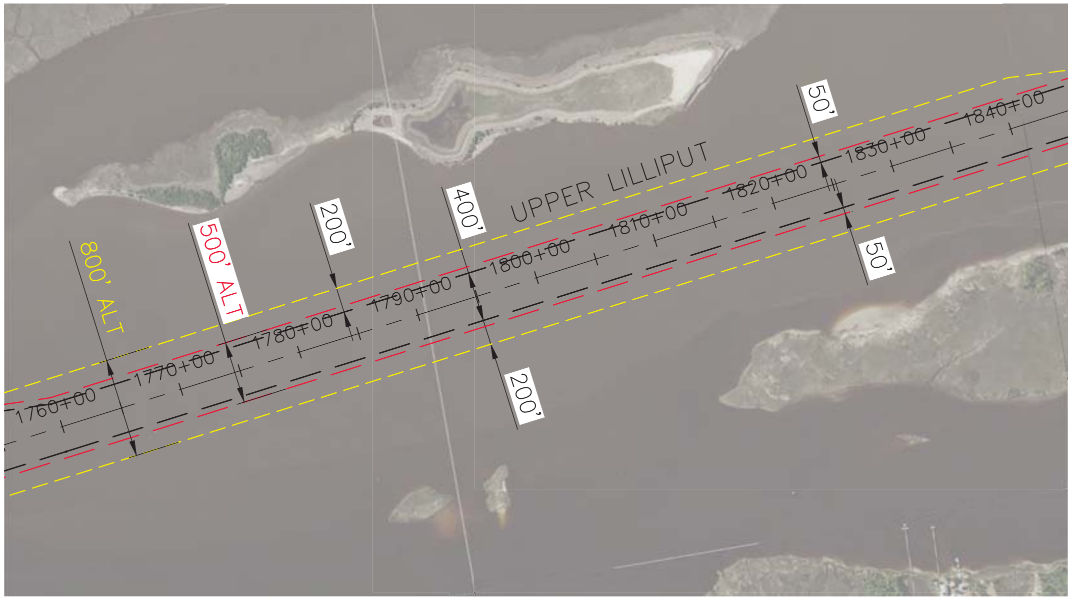
Simulated Channel Layouts
Station 970+00 to 1170+00



Simulated Channel Layouts
Station 1180+00 to 1345+00

Simulated Channel Layouts
Station 1345+00 to 1645+00

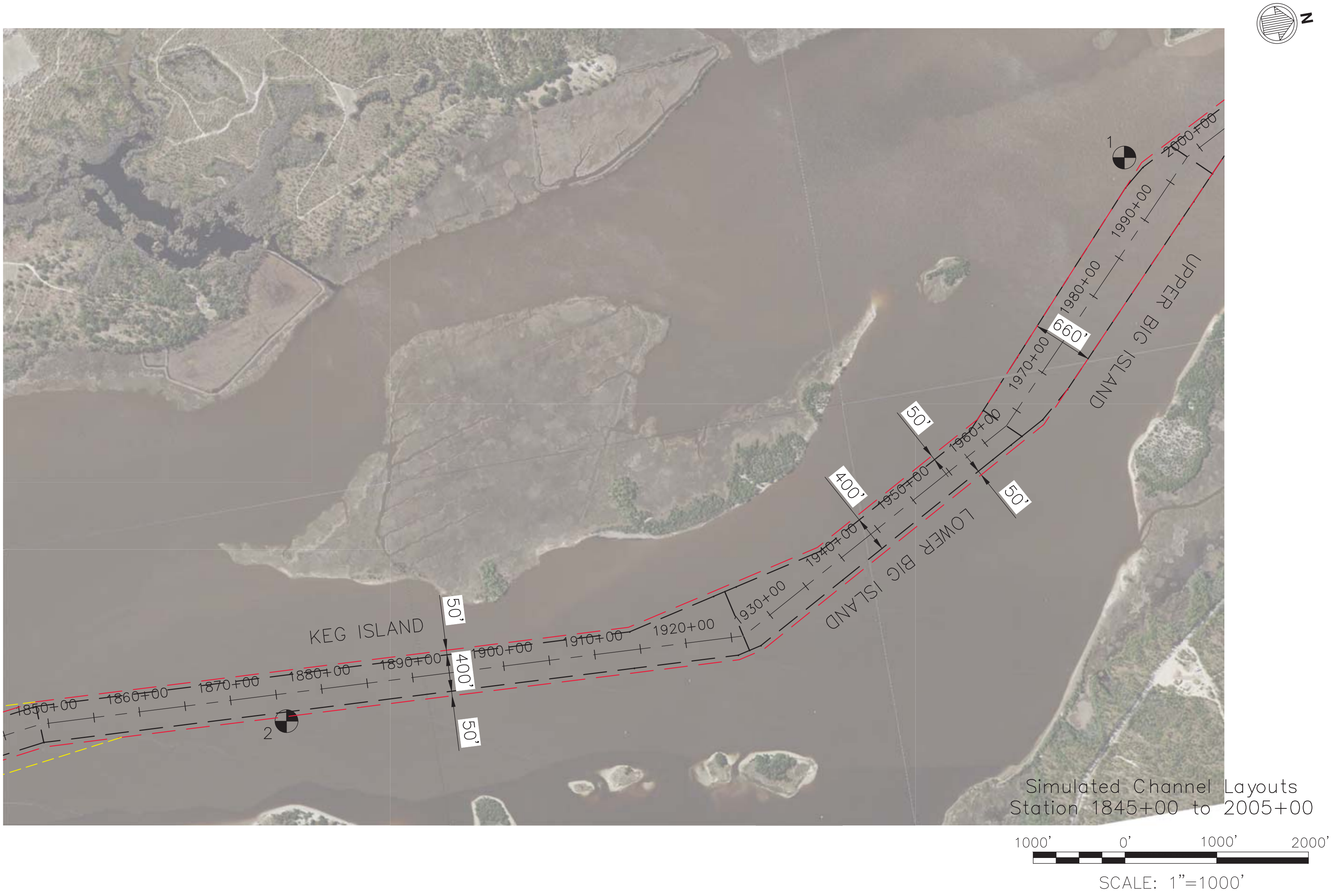




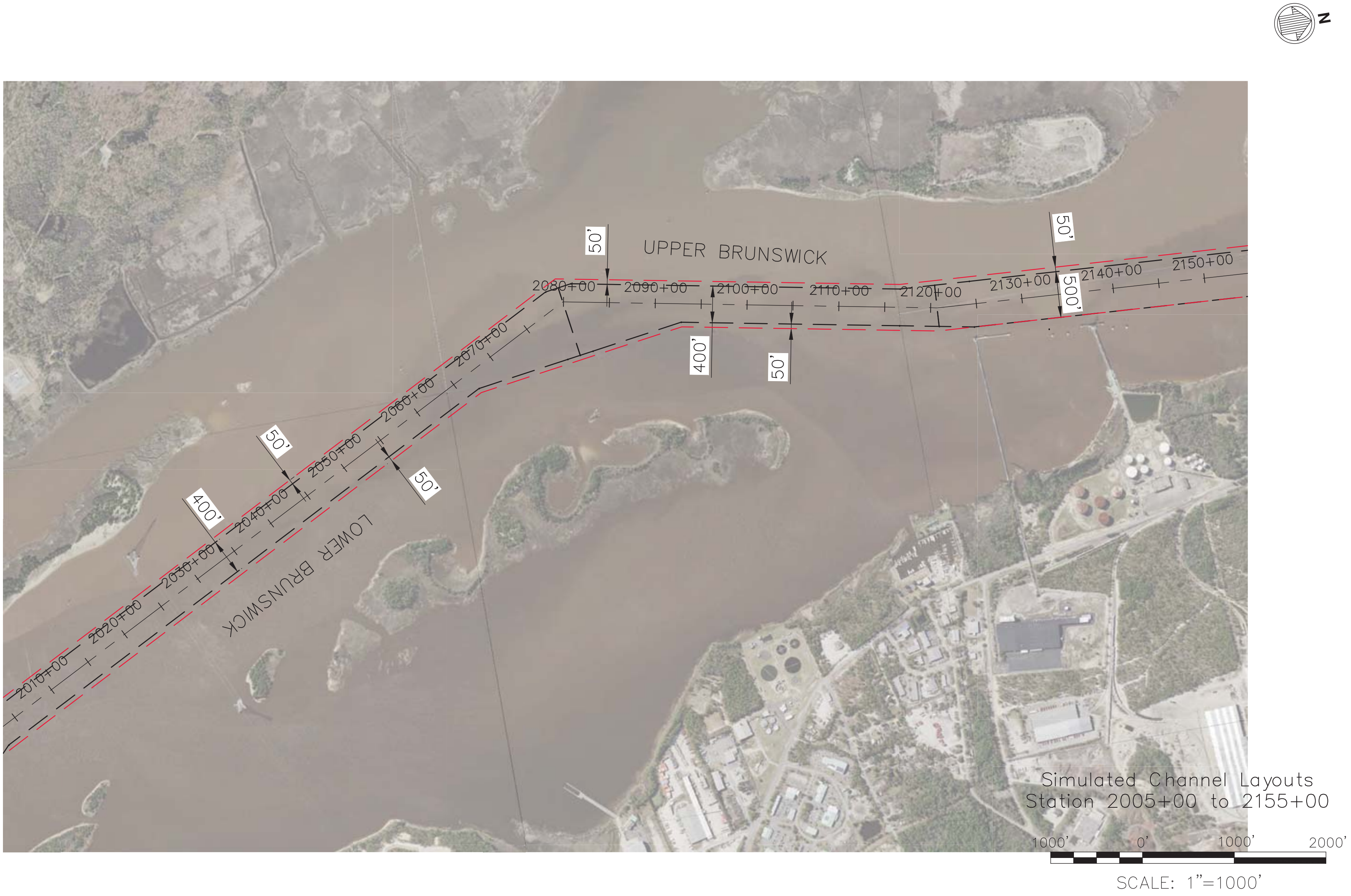
Simulated Channel Layouts
Station 1645+00 to 1845+00

1000' 0' 1000' 2000'

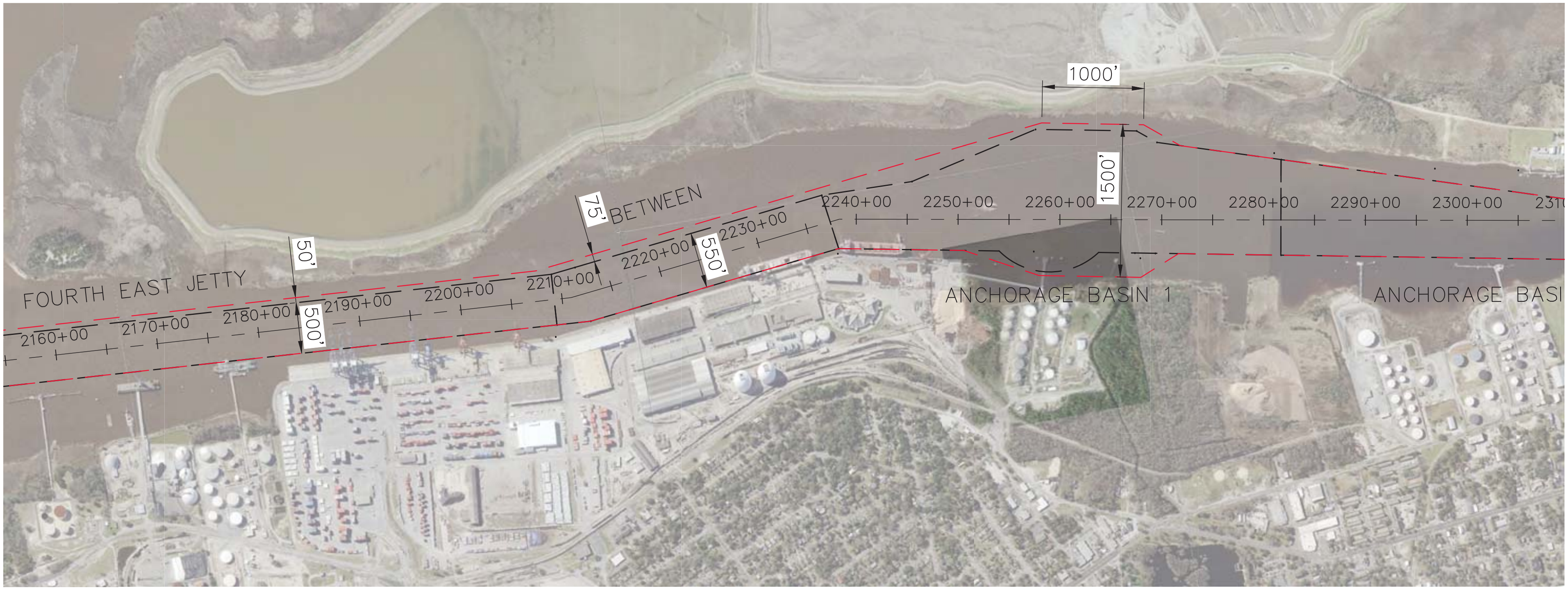
SCALE: 1"=1000'



Simulated Channel Layouts
Station 1845+00 to 2005+00



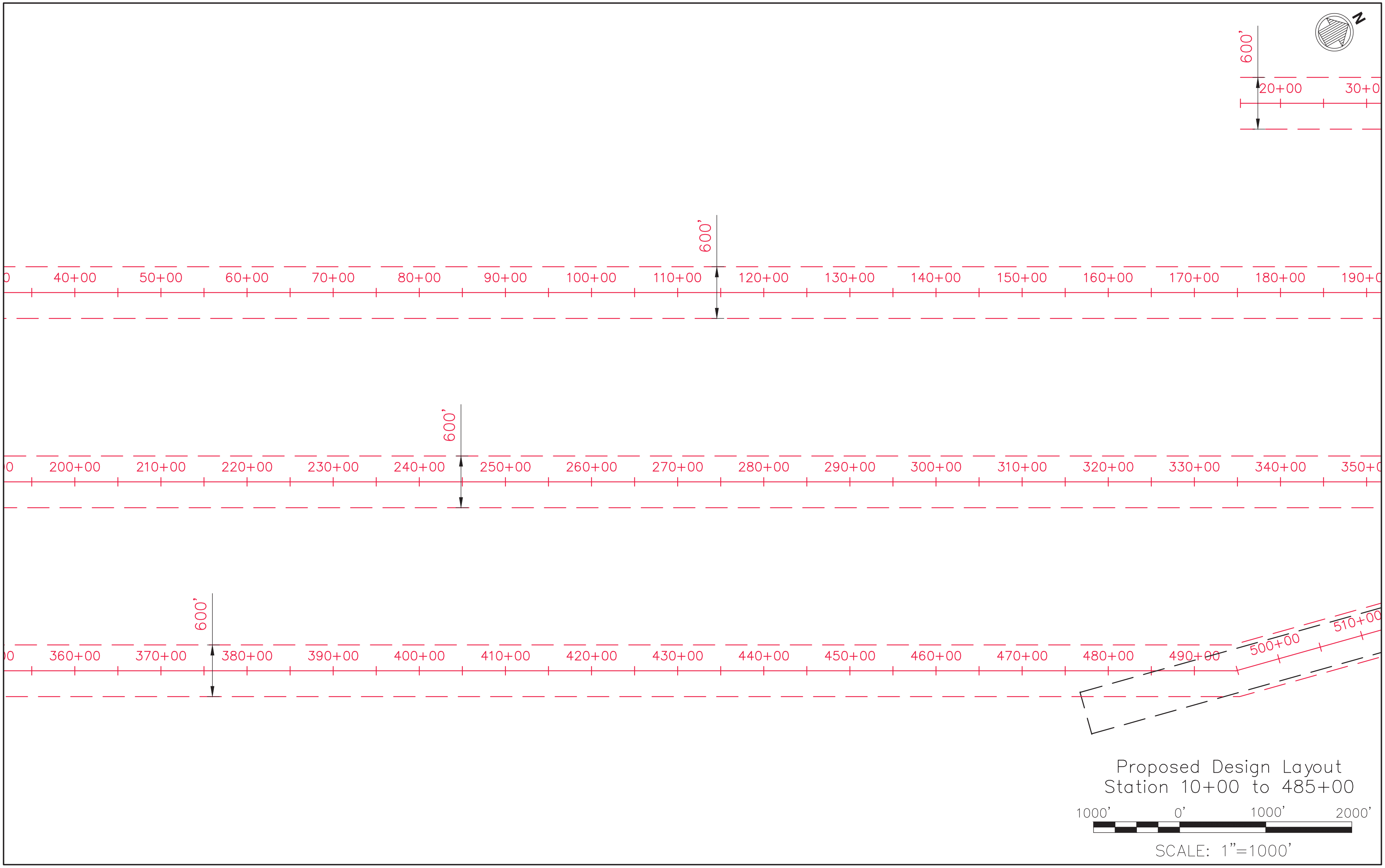
Simulated Channel Layouts
Station 2005+00 to 2155+00



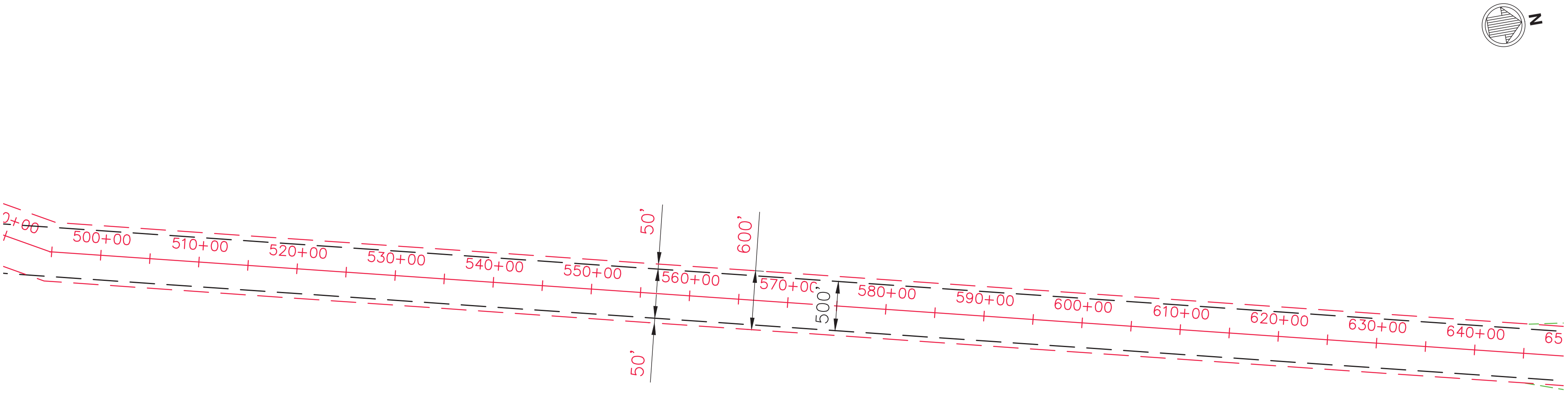
Simulated Channel Layouts
Station 2155+00 to 2310+00

1000' 0' 1000' 2000'

SCALE: 1"=1000'



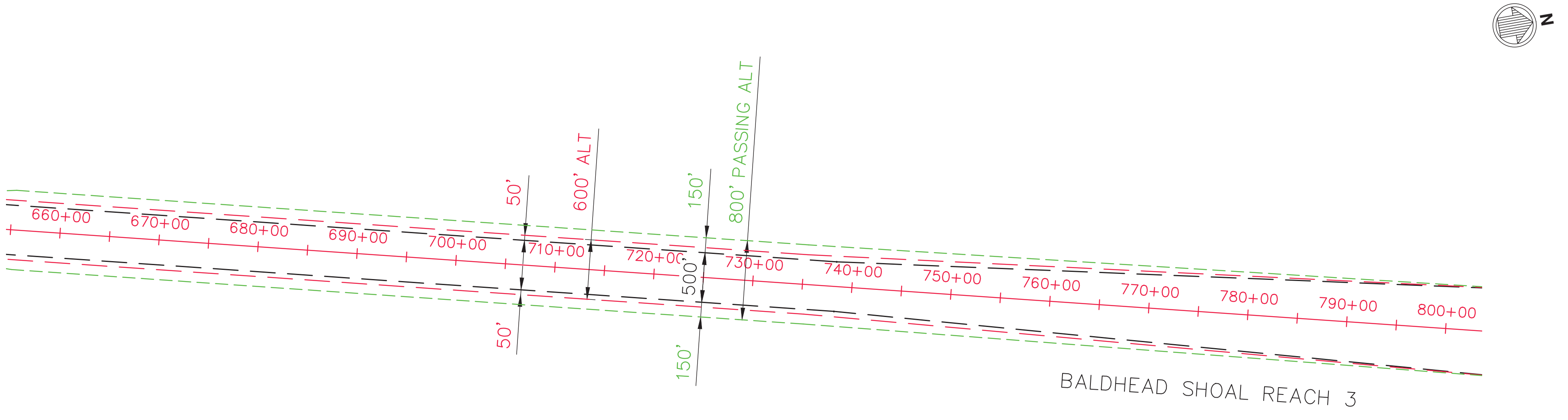
Proposed Design Layout
Station 10+00 to 485+00



Proposed Design Layout
Station 485+00 to 645+00

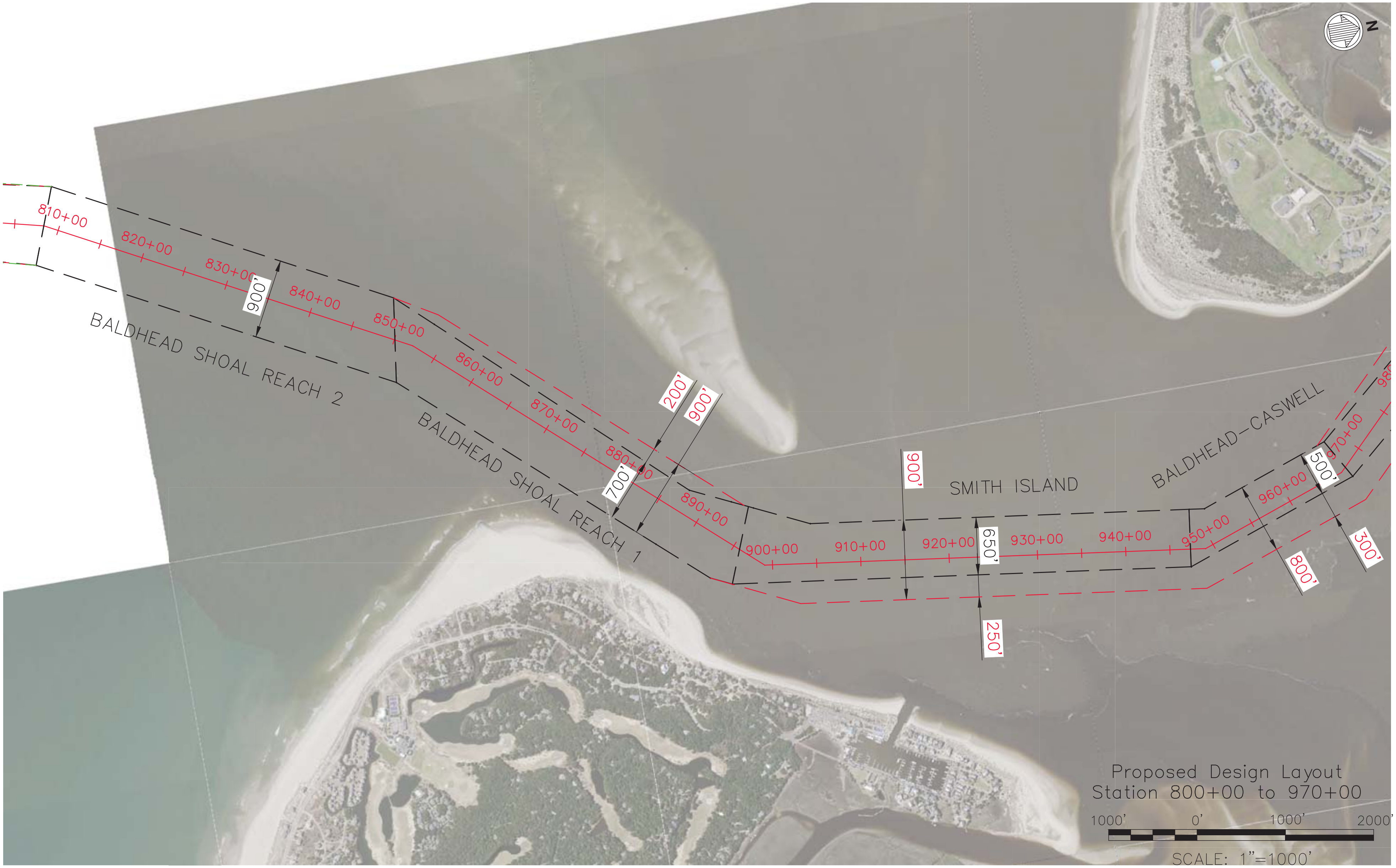
1000' 0' 1000' 2000'

SCALE: 1"=1000'



Proposed Design Layout
Station 650+00 to 800+00

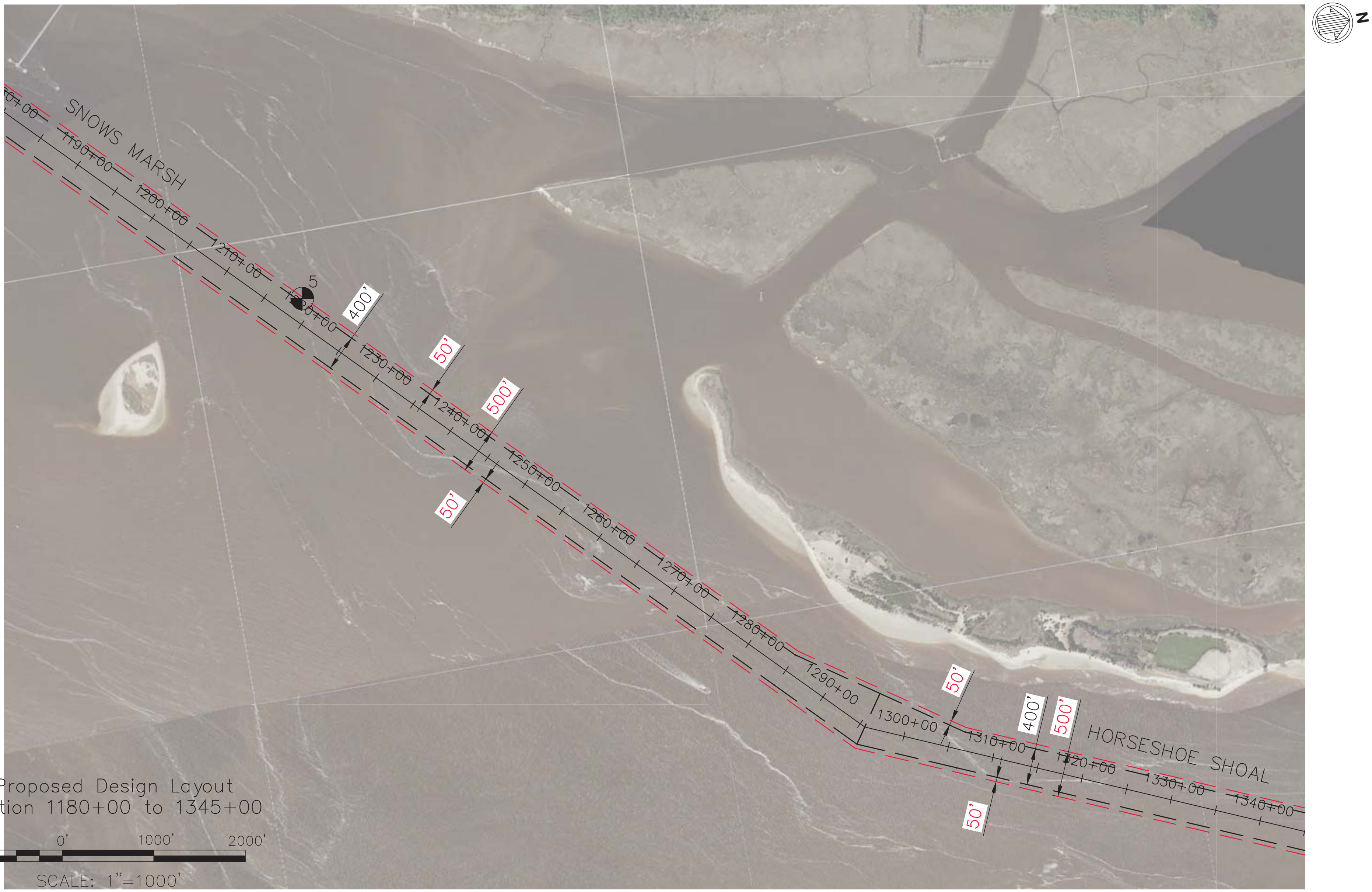
SCALE: 1"=1000'



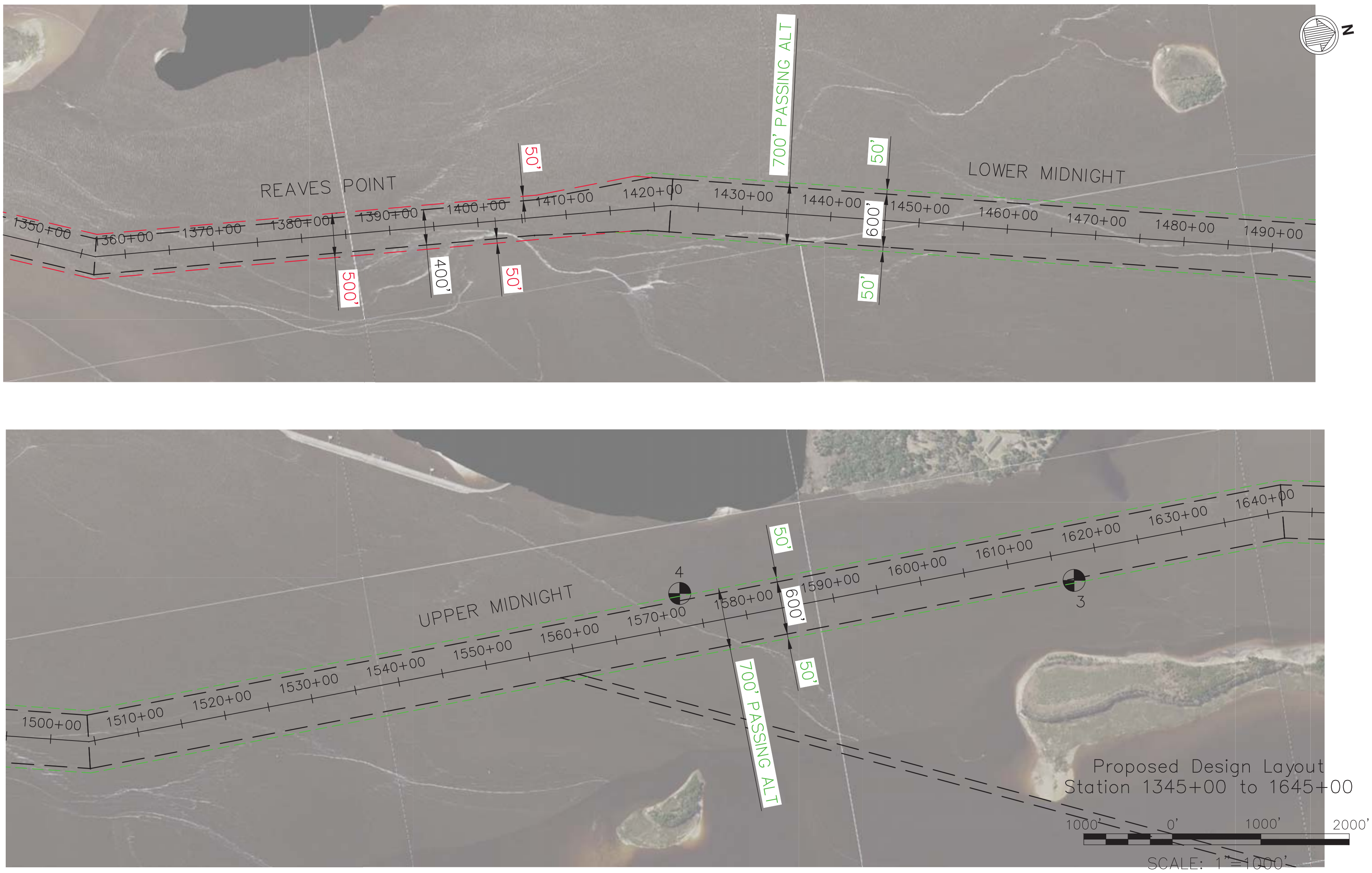
Proposed Design Layout
Station 800+00 to 970+00

SCALE: 1"=1000'

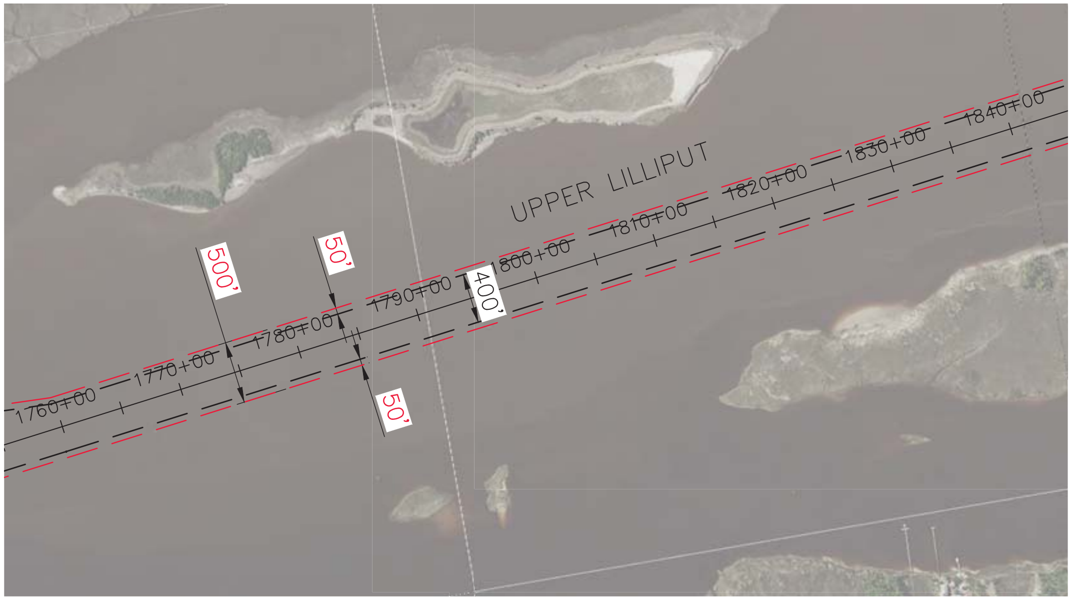
Proposed Design Layout
Station 970+00 to 1170+00



Proposed Design Layout
Station 1180+00 to 1345+00

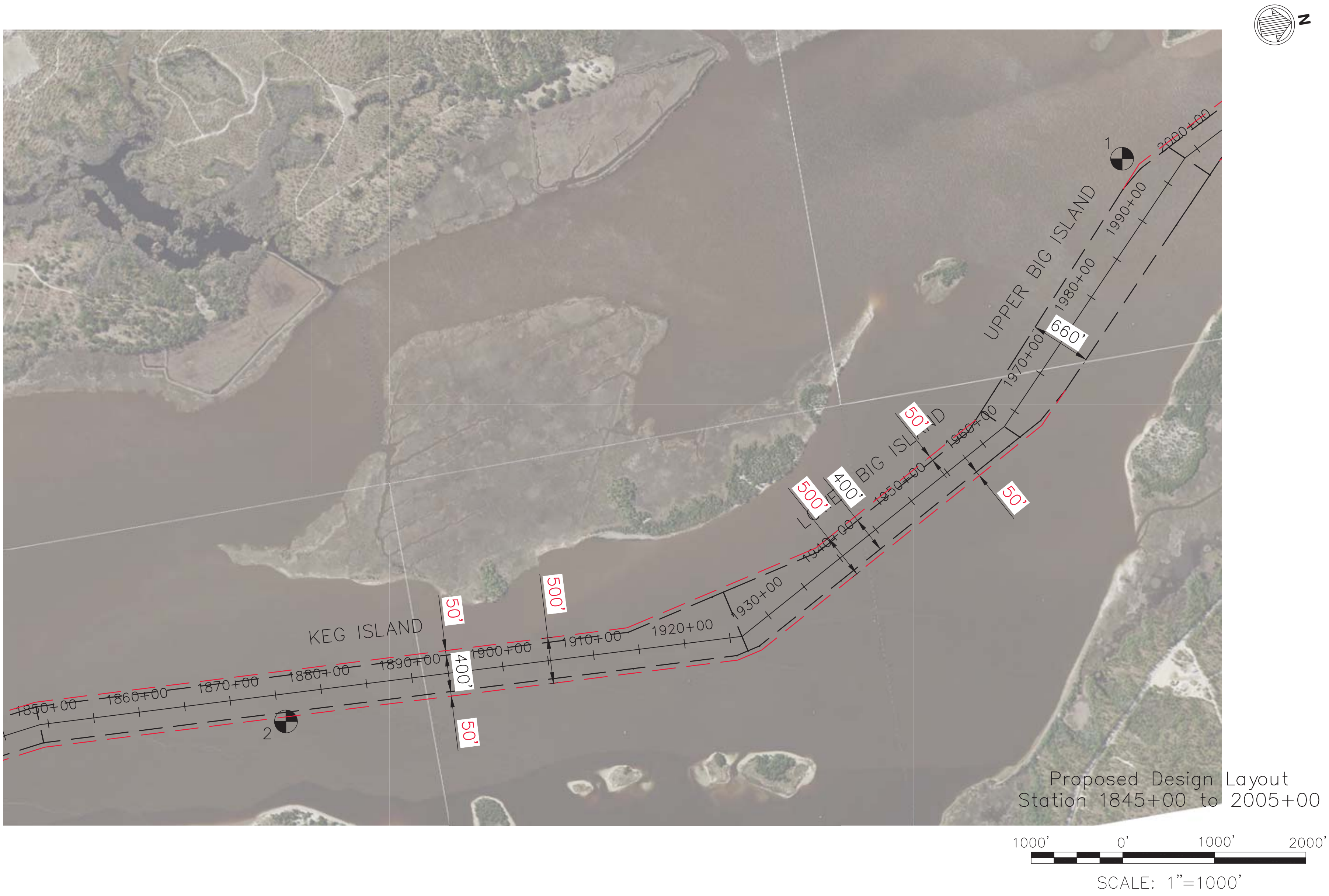


Proposed Design Layout
Station 1345+00 to 1645+00

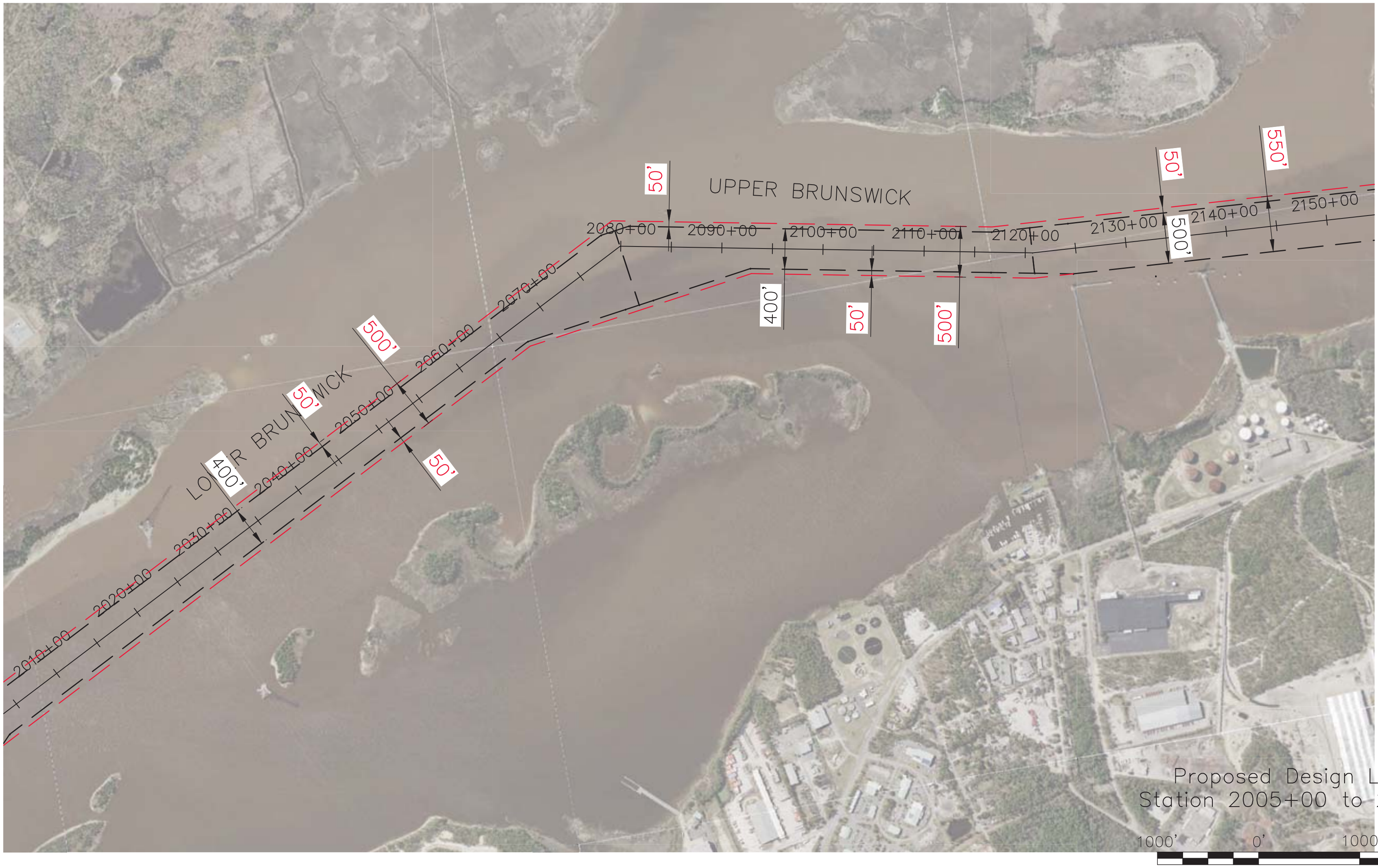


Proposed Design Layout
Station 1645+00 to 1845+00

SCALE: 1"=1000'

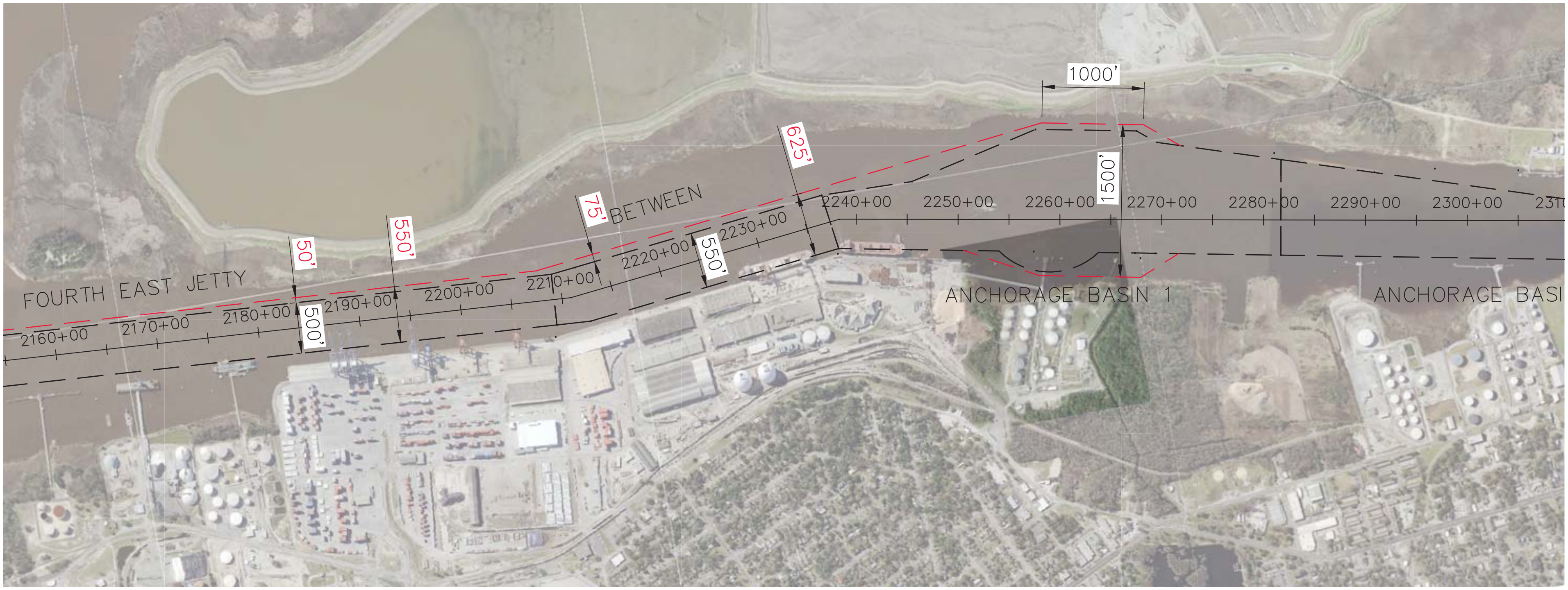


Proposed Design Layout
Station 1845+00 to 2005+00



Proposed Design Layout
Station 2005+00 to 2155+00

SCALE: 1"=1000'



Proposed Design Layout
Station 2155+00 to 2310+00

SCALE: 1"=1000'

Appendix B–2:
Pilot Cards

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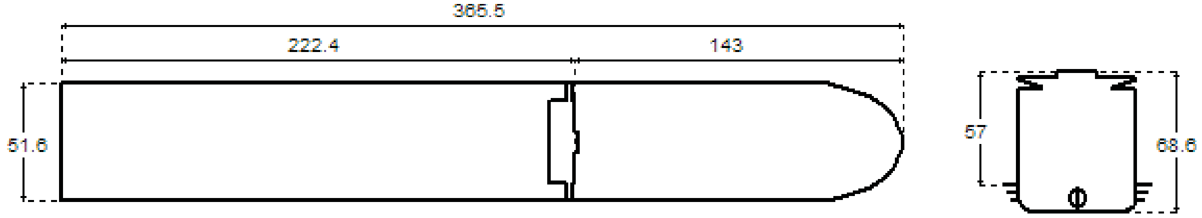
PILOT CARD

Ship name	Container ship 13 (13300 TEU) 3.0.27.0 *			Date	03.11.2015
IMO Number	N/A	Call Sign	N/A	Year built	2009
Load Condition	Part load 1				
Displacement	136423 tons		Draft forward	11.25 m / 37 ft 0 in	
Deadweight	156800 tons		Draft forward extreme	11.25 m / 37 ft 0 in	
Capacity			Draft after	11.55 m / 37 ft 11 in	
Air draft	57.1 m / 187 ft 9 in		Draft after extreme	11.55 m / 37 ft 11 in	

Ship's Particulars

Length overall	365.5 m	Type of bow	Bulbous
Breadth	51.65 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	14 / 17	(1 shackle =25 m / 13.7 fathoms)	
Max. rate of heaving, m/min	9 / 9		



Steering characteristics

Steering device(s) (type/No.)	Normal balance rudder / 1	Number of bow thrusters	2
Maximum angle	35	Power	1795 kW / 1795 kW
Rudder angle for neutral effect	0.33 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	22 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	326.6 s	7.89 cbls	Advance	6.08 cbls
HAH to HAS	384.6 s	6.63 cbls	Transfer	3.06 cbls
SAH to SAS	508.6 s	5.81 cbls	Tactical diameter	6.95 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 80080 kW	Propeller type	FPP
Astern power	68.4 % ahead	Min. RPM	20
Time limit astern	N/A	Emergency FAH to FAS	31.2 seconds

Engine Telegraph Table

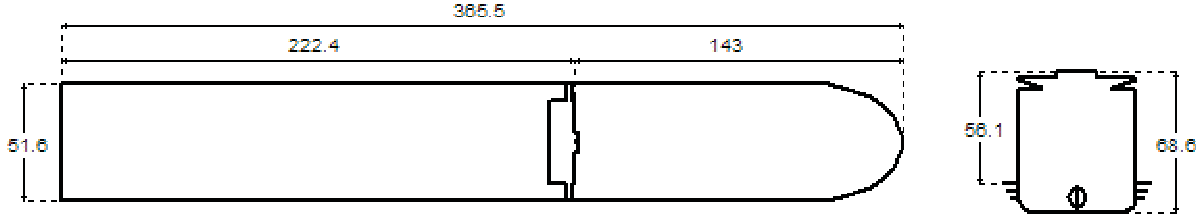
Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	27.4	72202	94.9	0.93
"FAH"	18	25023	65.6	0.93
"HAH"	13.6	11816	50.2	0.93
"SAH"	9.3	4447	35.1	0.93
"DSAH"	6.6	1883	24.7	0.93
"DSAS"	-3	2597	-25	0.93
"SAS"	-4.2	6464	-35	0.93
"HAS"	-6.3	17671	-50	0.93
"FAS"	-8.1	37937	-65	0.93

PILOT CARD

Ship name	Container ship 13 (13300 TEU)	3.0.27.0 *		Date	03.11.2015
IMO Number	N/A	Call Sign	N/A	Year built	2009
Load Condition	Part load 3				
Displacement	154191 tons		Draft forward		12.5 m / 41 ft 1 in
Deadweight	156800 tons		Draft forward extreme		12.5 m / 41 ft 1 in
Capacity			Draft after		12.5 m / 41 ft 1 in
Air draft	56.15 m / 184 ft 8 in		Draft after extreme		12.5 m / 41 ft 1 in

Ship's Particulars

Length overall	365.5 m	Type of bow	Bulbous
Breadth	51.65 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	14 / 17		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	9 / 9		



Steering characteristics

Steering device(s) (type/No.)	Normal balance rudder / 1	Number of bow thrusters	2
Maximum angle	35	Power	1795 kW / 1795 kW
Rudder angle for neutral effect	0.33 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	22 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	356.6 s	8.45 cbls	Advance	5.8 cbls
HAH to HAS	425.6 s	7.27 cbls	Transfer	2.77 cbls
SAH to SAS	564.6 s	6.41 cbls	Tactical diameter	6.37 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 80080 kW	Propeller type	FPP
Astern power	68.4 % ahead	Min. RPM	20
Time limit astern	N/A	Emergency FAH to FAS	31.2 seconds

Engine Telegraph Table

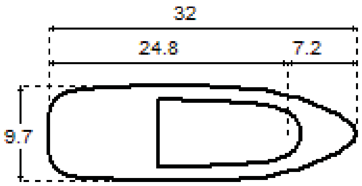
Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	27.2	72308	94.7	0.93
"FAH"	17.8	25083	65.5	0.93
"HAH"	13.5	11841	50.1	0.93
"SAH"	9.1	4461	35.1	0.93
"DSAH"	6.4	1883	24.7	0.93
"DSAS"	-2.9	2596	-25	0.93
"SAS"	-4.1	6467	-34.9	0.93
"HAS"	-6.1	17658	-49.9	0.93
"FAS"	-7.8	37930	-64.9	0.93

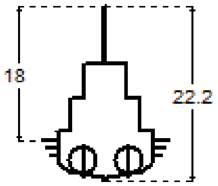
PILOT CARD

Ship name	Conventional twin screw tug 5 (bp 32t) TRANSAS 2.31.12.0 *			Date	06.06.2013
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	535 tons		Draft forward		3.05 m / 10 ft 0 in
Deadweight	N/A tons		Draft forward extreme		3.05 m / 10 ft 0 in
Capacity			Draft after		4.27 m / 14 ft 0 in
Air draft	18.01 m / 59 ft 2 in		Draft after extreme		4.27 m / 14 ft 0 in

Ship's Particulars

Length overall	32 m	Type of bow	-
Breadth	9.75 m	Type of stern	Transom
Anchor(s) (No./types)	1 (PortBow)		
No. of shackles	9		(1 shackle =27.4 m / 15 fathoms)
Max. rate of heaving, m/min	30		





Steering characteristics

Steering device(s) (type/No.)	Suspended / 2	Number of bow thrusters	N/A
Maximum angle	45	Power	N/A
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	23 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping

Description	Full Time	Head reach
FAH to FAS	38.6 s	0.67 cbls
HAH to HAS	33.35 s	0.5 cbls
SAH to SAS	27.25 s	0.3 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees	
Advance	0.49 cbls
Transfer	0.24 cbls
Tactical diameter	0.51 cbls

Main Engine(s)

Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Inward
Maximum power per shaft	2 x 1104 kW	Propeller type	FPP
Astern power	80 % ahead	Min. RPM	5.83
Time limit astern	N/A	Emergency FAH to FAS	5.15 seconds

Engine Telegraph Table

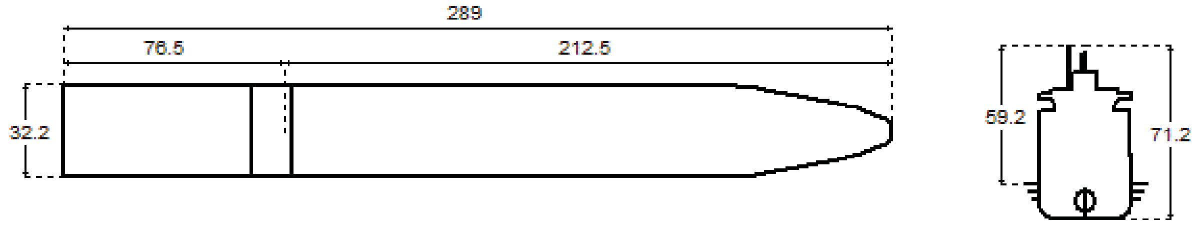
Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	11.8	2098	211.8	0.75
"FAH"	10.2	1374	184	0.75
"HAH"	8.8	820	155.8	0.75
"SAH"	7.2	454	127.5	0.75
"DSAH"	5.6	217	98.5	0.75
"DSAS"	-4.5	406	-91.4	0.75
"SAS"	-5.2	620	-105.6	0.75
"HAS"	-5.9	890	-119.4	0.75
"FAS"	-6.6	1242	-133.7	0.75
"FSAS"	-7.3	1678	-148	0.75

PILOT CARD

Ship name	Container ship 19 (Dis.66700t) TRANSAS 2.31.3.0 *			Date	02.02.2012
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	66700 tones		Draft forward	12 m / 39 ft 5 in	
Deadweight	59500 tonnes		Draft forward extreme	12 m / 39 ft 5 in	
Capacity			Draft after	12 m / 39 ft 5 in	
Air draft	59.25 m / 194 ft 10 in		Draft after extreme	12 m / 39 ft 5 in	

Ship's Particulars

Length overall	289 m	Type of bow	Bulbous
Breadth	32.2 m	Type of stern	Transom
Anchor Chain(Port)	13 shackles		
Anchor Chain(Starboard)	13 shackles		
Anchor Chain(Stern)	N/A shackles	(1 shackle =27.5 m / 15 fathoms)	



Steering characteristics

Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	2
Maximum angle	35	Power	2000 kW / 2000 kW
Rudder angle for neutral effect	0.06 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	14 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	

Stopping

Description	Full Time	Head reach
FAH to FAS	484.6 s	12.15 cbls
HAH to HAS	582.6 s	8.31 cbls
SAH to SAS	789.6 s	8.32 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees

Advance	4.06 cbls
Transfer	2.13 cbls
Tactical diameter	4.77 cbls

Main Engine(s)

Type of Main Engine	Slow speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 28700 kW	Propeller type	FPP
Astern power	10 % ahead	Min. RPM	26.86
Time limit astern	N/A	Emergency FAH to FAS	2.1 seconds

Engine Telegraph Table

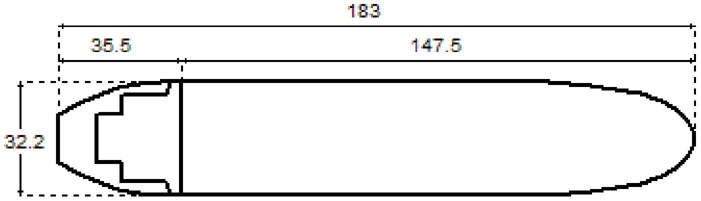
Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
Full Sea Ahead	23.5	27206	92.9	0.8
Full Ahead	16.9	12151	67.1	0.8
Half Ahead	11.8	4591	47.1	0.8
Slow Ahead	9	2448	36.9	0.8
Dead Slow Ahead	6.7	1343	27.3	0.8
Dead Slow Astern	-2.4	1432	-26.6	0.8
Slow Astern	-3.3	2866	-35	0.8
Half Astern	-4.5	6782	-47.4	0.8
Full Astern	-6.4	18120	-67.1	0.8

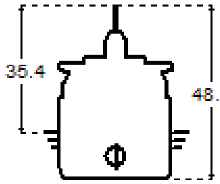
PILOT CARD

Ship name	Chemical tanker 7 3.0.7.0 *			Date	03.12.2013
IMO Number	9439773	Call Sign	N/A	Year built	2009
Load Condition	Load Condition 1				
Displacement	60976 tons		Draft forward	13 m / 42 ft 9 in	
Deadweight	50161 tons		Draft forward extreme	13 m / 42 ft 9 in	
Capacity			Draft after	13 m / 42 ft 9 in	
Air draft	35.46 m / 116 ft 7 in		Draft after extreme	13 m / 42 ft 9 in	

Ship's Particulars

Length overall	183 m	Type of bow	Bulbous
Breadth	32.2 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	14 / 14		(1 shackle =27.5 m / 15 fathoms)
Max. rate of heaving, m/min	9 / 9		





Steering characteristics

Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	N/A
Maximum angle	35	Power	N/A
Rudder angle for neutral effect	0.51 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	15 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping

Description	Full Time	Head reach
FAH to FAS	455.6 s	8.33 cbls
HAH to HAS	626.6 s	6.67 cbls
SAH to SAS	941.6 s	6.74 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees

Advance	3.35 cbls
Transfer	1.34 cbls
Tactical diameter	3.08 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 9500 kW	Propeller type	FPP
Astern power	60 % ahead	Min. RPM	25
Time limit astern	N/A	Emergency FAH to FAS	56.2 seconds

Engine Telegraph Table

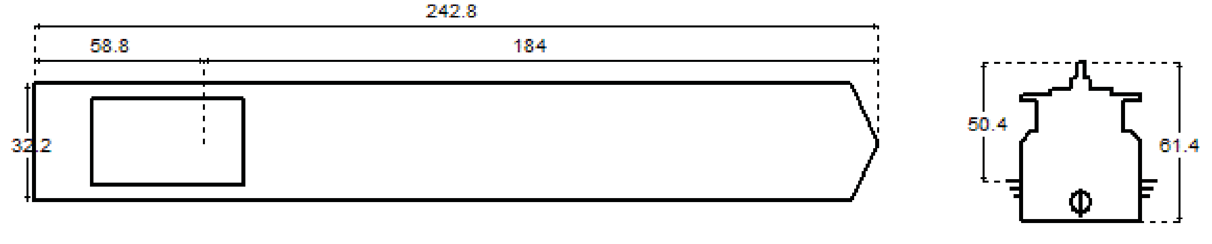
Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	15.7	8550	127	0.67
"FAH"	12.4	4177	100	0.67
"HAH"	9.3	1763	75	0.67
"SAH"	6.8	696	55	0.67
"DSAH"	3.7	114	30	0.67
"DSAS"	-1.5	155	-30	0.67
"SAS"	-2	366	-40	0.67
"HAS"	-3.1	1232	-60	0.67
"FAS"	-5.1	5699	-99.9	0.67

PILOT CARD

Ship name	Oil tanker 3 (Dis.67850t) TRANSAS 2.31.6.0 *			Date	12.01.2012
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	67850 tones		Draft forward	11 m / 36 ft 2 in	
Deadweight	59708 tonnes		Draft forward extreme	11 m / 36 ft 2 in	
Capacity			Draft after	11 m / 36 ft 2 in	
Air draft	50.47 m / 166 ft 0 in		Draft after extreme	11 m / 36 ft 2 in	

Ship's Particulars

Length overall	242.8 m	Type of bow	Bulbous
Breadth	32.2 m	Type of stern	V-shaped
Anchor Chain(Port)	14 shackles		
Anchor Chain(Starboard)	14 shackles		
Anchor Chain(Stern)	N/A shackles	(1 shackle =27.5 m / 15 fathoms)	



Steering characteristics

Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	1
Maximum angle	35	Power	1200 kW
Rudder angle for neutral effect	0.7 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	30 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	

Stopping

Description	Full Time	Head reach
FAH to FAS	372.6 s	7.23 cbls
HAH to HAS	365.6 s	5.96 cbls
SAH to SAS	450.6 s	5.3 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees	
Advance	3 cbls
Transfer	1.34 cbls
Tactical diameter	3.35 cbls

Main Engine(s)

Type of Main Engine	Slow speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 12000 kW	Propeller type	FPP
Astern power	56 % ahead	Min. RPM	35.54
Time limit astern	N/A	Emergency FAH to FAS	11.8 seconds

Engine Telegraph Table

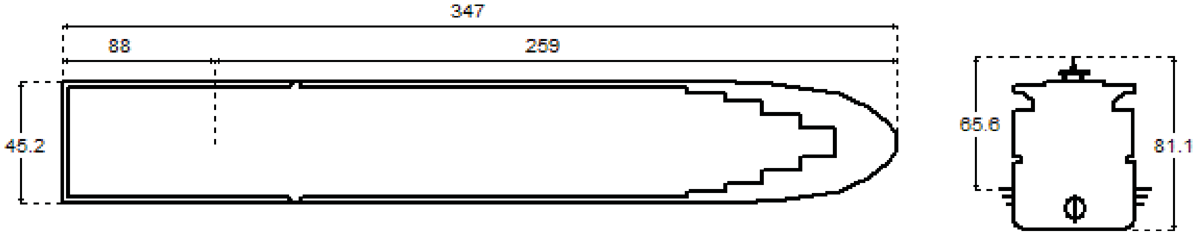
Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
Full Sea Ahead	15	11000	100.5	0.75
Full Ahead	13.6	8492	91.5	0.75
Half Ahead	11.4	5064	76.8	0.75
Slow Ahead	8.5	2129	56.9	0.75
Dead Slow Ahead	5.5	605	36.5	0.75
Dead Slow Astern	-2.2	598	-36.1	0.75
Slow Astern	-3.7	1824	-54.6	0.75
Half Astern	-5.2	4598	-75	0.75
Full Astern	-5.7	6043	-81.9	0.75

PILOT CARD

Ship name	Container ship 12 (Dis.164300) TRANSAS 2.31.5.0 *			Date	14.07.2014
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	164300 tons		Draft forward	15.5 m / 50 ft 11 in	
Deadweight	125696 tons		Draft forward extreme	15.5 m / 50 ft 11 in	
Capacity			Draft after	15.5 m / 50 ft 11 in	
Air draft	65.65 m / 215 ft 11 in		Draft after extreme	15.5 m / 50 ft 11 in	

Ship's Particulars

Length overall	347 m	Type of bow	Bulbous
Breadth	45.2 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	бесконечность / бесконечность		(1 shackle =0 m / 0 fathoms)
Max. rate of heaving, m/min	10.2 / 10.2		



Steering characteristics

Steering device(s) (type/No.)	Becker's rudder / 1	Number of bow thrusters	1
Maximum angle	35	Power	3000 kW
Rudder angle for neutral effect	0.14 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	14 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping

Description	Full Time	Head reach
FAH to FAS	465.6 s	9.84 cbls
HAH to HAS	589.6 s	9.38 cbls
SAH to SAS	750.6 s	8.15 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees

Advance	5.21 cbls
Transfer	2.53 cbls
Tactical diameter	5.23 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 72243 kW	Propeller type	FPP
Astern power	66 % ahead	Min. RPM	20
Time limit astern	N/A	Emergency FAH to FAS	1.1 seconds

Engine Telegraph Table

Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	25.5	68896	103.9	0.93
"FAH"	14.4	18128	64.8	0.93
"HAH"	11.3	8384	49.7	0.93
"SAH"	7.9	3305	35.6	0.93
"DSAH"	3.8	1054	22	0.93
"DSAS"	-2	1775	-21.2	0.93
"SAS"	-4.1	6877	-34.8	0.93
"HAS"	-6.1	18981	-49	0.93
"FAS"	-8.4	44817	-64.9	0.93

Appendix B–3:
Completed Pilot Evaluation Forms

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9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/24/2018
Simulation #: 1
Pilot: Scott Aldridge

FAMILIARIZATION

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2 SNM

Time: *(Start)* 12:00 *(End)*

Channel Station: *(Start)* BH3 ~ ~~750~~ 750 *(End)* 1180

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): —

Ship Model *(Piloted Vessel)*: CS19

Load Condition: ~~PLT~~ 0

Ship Model *(Passing Vessel)*: —

used scene: 9232-06 NCSPA_V12 - existing

Available Tug Power:

Tug #1 *(Type/Power)*
Tug #2 *(Type/Power)*
Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 10 Kts SW
Waves *(Hs / Tp / Dir)*: 1m 8s 202.5
Current *(stage / start time)*: Slack 11 AM
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
12:13	Pilot thought the ship should have better ROT
12:26	Buoy 16 & Buoy 18 have been moved, Buoy 16 half way to invert to the South, Buoy 18 moved west just north of the cutoff
12:27	Rot not as expected, getting ~13 expecting 18-20
12:29 -	Ran aground in turn, moved ship and re tried turn
12:31	Starting turn earlier than normal
12:34	Ran aground in turn, * moved ship and re-tried turn x2

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

    Safety:

    Tug Adequacy:

    Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/24/2018
Simulation #: 2A
Pilot: Scott Aldridge

FAMILIARIZATION

Simulation 2 was not run
↓
For simplicity This will be named Sim 2

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 BH3 Design Layout #2 SNM

Time: *(Start)* 11:10 *(End)*

Channel Station: *(Start)* 740 *(End)* 1190

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: Container 13

Load Condition: Part load 1

Ship Model *(Passing Vessel)*: —

Scene: V12_existing

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 10 KTS SW

Waves *(Hs / Tp / Dir)*: 1m 8s 202.5

Current *(stage / start time)*: slack 11AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Familiarization run with design ship

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

    Safety:

    Tug Adequacy:

    Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/24/2018
Simulation #: 3
Pilot: Scott Aldridge

FAMILIARIZATION

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2
Time: *(Start)* 12:32 *(End)*
Channel Station: *(Start)* 990 SOP *(End)* 1120 LSW
Direction of Transit: [✓ Inbound] / Outbound
Berth (docking/undocking only):
Ship Model *(Piloted Vessel)*: CS19
Load Condition: 0
Ship Model *(Passing Vessel)*:
Scene: V13_existing

Available Tug Power:

Tug #1 *(Type/Power)*
Tug #2 *(Type/Power)*
Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 10 Kts SW
Waves *(Hs / Tp / Dir)*: 1m 8s 202.5
Current *(stage / start time)*: Slack Existing 11AM
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Familiarization
	Water Tower moved to correct location and Red Buoy 16 and 18 moved to new location

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 9 10
Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10
Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1|24|2018
Simulation #: 4
Pilot: Bill Hine

FAMILIARIZATION

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2

Time: *(Start)* 12:48 *(End)*

Channel Station: *(Start)* 740 *(End)* 1080

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): BH3 — LSW

Ship Model *(Piloted Vessel)*: CS19

Load Condition: 0

Ship Model *(Passing Vessel)*: —

Scene: V13_existing

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 10 Kts SW

Waves *(Hs / Tp / Dir)*: 1m 8s 202 5

Current *(stage / start time)*: Slack Existing 11AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Familiarization

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/24/2018
Simulation #: 5
Pilot: S. Aldridge

EXISTING Full Simulation

Simulation Summary:

Simulation Layout: [✓ Existing Channel]
Design Layout #1 BH3
Design Layout #2 Pilot Boarding

Time: *(Start)* 1:34 PM *(End)*

Channel Station: *(Start)* Offshore 490 *(End)* Turning Basin TB 2200

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): —

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL1

Ship Model *(Passing Vessel)*: —

Available Tug Power:

Tug #1 *(Type/Power)* Z 53t.

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 10kts 225

Waves *(Hs / Tp / Dir)*: 1m / 8s / 202.5

Current *(stage / start time)*: Flood 7am

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
12:08	2x Bald Head Shoal Reach 3 on straight away
12:33	Ship grounded - Smith Range, Eastern side
12:47	Ship grounded - Lower Swash, Western side
12:53	2x speed at lower swash Commented by ADM may need an assit tug to get by ADM because hard to slow down with ~3kt current assist tug to slow ship down
13:11	Ran aground - unknown why, Reaves Pt.
13:22	Up to 2x
13:40	Down to 1x
13:47	up to 2x
13:59	down to 1x

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 [✓ 5] 6 7 8 9 10 — Margin of error so small.

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 [✓ 6] 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Run weather conditions were ideall

Tug Adequacy: Change in conditions would greatly impact safety

Difficulty: Harbor very close, highly suggest widening to maximum.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes - typical locations where leave the channel for turns wouldn't have grounded as did in the simulation

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

As expected

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes.

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes - would need tug boat at battery island

6. Please provide any comments on aids to navigation placement and range configurations:

Accurate.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Significant learning curve.

8. Additional Commentary:

Having the additional area is critical especially in the harbor and southport turn

ROT higher than expected.
No margin of error, using maximum turn.

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Date: 1/24/2018
Simulation #: 6
Pilot: S Aldridge

Outbound existing
Battery Island Turn

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2

Time: *(Start)* 4:29 PM *(End)* ____

Channel Station: *(Start)* 1200 SNM *(End)* 670 BH3

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): ____

Ship Model *(Piloted Vessel)*: CS13 PL1

Load Condition: PL1

Ship Model *(Passing Vessel)*: ____

Available Tug Power:

Tug #1 *(Type/Power)* ____

Tug #2 *(Type/Power)* ____

Tug #3 *(Type/Power)* ____

Environmental Conditions:

Wind *(Speed / Direction)*: 10 kts / 225

Waves *(Hs / Tp / Dir)*: 1 m 8s

Current *(stage / start time)*: Flood 8AM

Water Level: MLW

Notes During Simulation:

Time	Observations/Notes
	Pilot wanted to start at ~4/5 knots however slowest speed allowed 6.1 kts — slowed immediately to pass ADM
12:09	up the model to 2x.
12:15	down to 1x speed.
12:45	up the wind to 15 knots from
	Pilot reccomended to increase the current to really test the narrow channel
12:49	changed wind to be from 270°

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	[✓ 7]	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	[✓ 5]	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Weather conditions are ideall

Tug Adequacy:

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

No - User error north of battery island ideally would have stayed closer to the G side of channel

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

As expected, unclear if pilot error or bank effect of why ended on the Red Side.

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

With tug assit and more simulations and assuming ship will respond as it did in the model.

6. Please provide any comments on aids to navigation placement and range configurations:

All sufficent.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Limit post-panamax ships to winds of 25 mph.

ROT higher than expected.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
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Date: 1/25/2018
Simulation #: 7
Pilot: Steve Phillips

Inbound Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 8:13 AM *(End)*________ Channel Station: *(Start)* 750 *(End)* 1200

Direction of Transit: [✓ Inbound] / Outbound Berth (docking/undocking only): BH3 SNM

Ship Model *(Piloted Vessel)*: CS13 Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)*________

Tug #2 *(Type/Power)*________

Tug #3 *(Type/Power)*________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SW

Waves *(Hs / Tp / Dir)*: 1 m / 8s / 202.5

Current *(stage / start time)*: Slack 11 AM

Water Level: MLLW

Notes During Simulation:

Familiarization

Time	Observations/Notes
	To get passed ADM w ship on Berth must go ~ 5 kts
	ADM - dock upriver due to Ebb tide. Turn after berth
12:50	2x speed
	Red Buoy @ apex of Battery Turn

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	[✓ 10]
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	[✓ 3]	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: —

   Tug Adequacy:

   Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   Remove Buoy 17 (green) at apex of turn and instead place Red Buoy at apex, Sewage House w. lights

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   —

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Date: 1/25/2018
Simulation #: 8
Pilot: Steve Phillips

Battery Island turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 9:20 AM *(End)* ________

Channel Station: *(Start)* 800 *(End)* 910

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): BH3 SMI

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts SW

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
12:00	Pilot went wrong way on rudder, correcting with hard right
	Ran aground in Smith Range
	(X) Restarted Simulation → Simulation #9
	Simulation do not include in evaluation

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   [illegible]

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

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Date: 1/25/2018
Simulation #: 9
Pilot: Steve Phillips

Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 9:40 AM *(End)* ________

Channel Station: *(Start)* 770 *(End)* 1200

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): BH3 SNM

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts | SW

Waves *(Hs / Tp / Dir)*: 1.5m | 8s | 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Stern along Bald Head Caswell, Battery, and lower Swash left the channel
12:36	Threw in reverse to slow for ADM, Bow reacted slower than pilot expected
	Recommend Assist tug for brakes at ADM
12:41	2x speed to pass ADM, had control

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 [✓ 2] 3 4 5 6 7 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Need an assist tug passing ADM

Tug Adequacy:

Difficulty: Adjustment and famiarization to the simulator

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Intended to be on the R side Lower Swash + G side Southport but did not intend to be outside in Bald Head Caswell

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Ship did not reverse as expected at ADM

Pull to port / Bow to starboard did not occur.

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes —

6. Please provide any comments on aids to navigation placement and range configurations:

Movement of Red buoy in apex of turn was sufficient.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Still getting famiar with simulator.

8. Additional Commentary:

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Date: 1/25/2018
Simulation #: 10
Pilot: Steve Phillips

Outbound Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*_______ *(End)*________

Channel Station: *(Start)* 1210 *(End)* 920

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): SNM SMI

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ________________

Available Tug Power:

Tug #1 *(Type/Power)*________________

Tug #2 *(Type/Power)*________________

Tug #3 *(Type/Power)*________________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 KTS SW

Waves *(Hs / Tp / Dir)*: 1.5m | 8s | 202.5

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
12:08	2x speed.
12:10	overloaded the system, brought back to 1x speed
12:11	2x speed, overloaded again brought back to 1x speed.
	Approx 7 kts through Battery Turn

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	[✓ 2]	3	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: —

Tug Adequacy:

Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

- Oak Light Channel Light 8 - Red, lit and used to set up Outbound turn at Battery Island.
- Southport Front Range Light visible 24 HRS

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

—

9232-06 Cape Fear River Navigation Simulations
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Date: 1/25/2018
Simulation #: 11
Pilot: Steve Phillips

3000' Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)* 12:23 *(End)* ________

Channel Station: *(Start)* 740 BH3 *(End)* 1190 SNM

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 KTS SW

Waves *(Hs / Tp / Dir)*: 1.5m/8s/202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Pilot stated that this turn feels more natural.
	Hard over rudder, full speed to make battery turn.
	Bank effect not being felt, stern swinging out of channel along battery turn
	After coming through apex turn Pilot states this turn more difficult compared to 4000 ft
	outside channel Lower Swash Red Side - unable to slow down safely for ADM, need assist tug

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 [✓ 6] 7 8 9 10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy:

Difficulty:

Run very similar to current alingment and protocol for existing simulation and therefore the reason this feels safer and less difficult.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Yes

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Red Buoy in apex of battery turn left concern for the pilot - more towards battery island 50 ft

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

—

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Date: 1/25/2018
Simulation #: 12
Pilot: Steve Phillips

3000' Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)* 13:24 *(End)*

Channel Station: *(Start)* 890 SMI *(End)* 1150 SNM

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3'

Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts SW

Waves *(Hs / Tp / Dir)*: 1.5m/8s/202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

- Smith Island to Bald Head Caswell turn needed full rudder full engine
- Bald Head Caswell - stern leaves channel red side
- Starting turn for Battery Island early.
- Stern leaving channel at apex of battery turn
- Need assist for this turn at battery island to hard to get back to red side after apex

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	[✓ 7]	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	[✓ 6]	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy:

Difficulty:

Comments the same as Simulation 1.1

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Max out engine and rudder

Pilot inclined to turning radius of 4000 ft vs 3000 ft

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Date: 1/25/2018
Simulation #: 13
Pilot: Steve Phillips

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* 830 BH2 *(End)* 1140 SNM

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts / SW

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Stern left channel Smith Island range + Battery Island

Time Observations/Notes

- Turn for Smith Island Range out of Bald Head Reach 1 go set too far to the Red side, Stern left channel.
- Wants to be on the Green Side @ the start of Southport Range but cant get there
- Currents expected to (in Real World) push into Elizabeth River but not in hydrodynamic model

⊛ at end the conning station locked up ⊛

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 [✓ 6] 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

   want to be able to set up on the G side of Southport, unable to turn enough to get there.

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Date: 1/25/2018
Simulation #: 14
Pilot: Steve Phillips

4000' Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 3 PM *(End)* ______

Channel Station: *(Start)* 830 *(End)* 1170

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): BH2 SNM

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SW

Waves *(Hs / Tp / Dir)*: 1.5 m 8s 202.5

Current *(stage / start time)*: Slack/Flood 6:30 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Unable to stay within the channel for previous simulations therefore changed tidal condition to rising flood.
	Was able to stay with the channel around battery Island turn and turn into Bald Head Caswell

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 [✓ 3] 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Ship at ADM need tug assist.

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   Buoy 16A needed @ apex of battery turn

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   Was able to stay within channel with reduced currents

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Simulation Summary, Notes, & Pilot Evaluation
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Date: 1/25/2018
Simulation #: 15
Pilot: Steve Phillips

4000' Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 3:48 PM *(End)*

Channel Station: *(Start)* 830 BH2 *(End)* 1110 LSW

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 Kts SW

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5m

Current *(stage / start time)*: Slack|Flood 6:30AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
12:24	Threw in reverse to simulate assist tug
12:25	When threw in reverse started really feeling the wind.
	Was able to stay in channel around Battery Island and coming into bald Head Caswell
	Left channel at end when started feeling the winds and slowing for ADM

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 [✓ 3] 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   Liked buoy at apex of battery turn

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

   - wants assist tug if ship is at ADM to get down to 5 kts
   - was able to stay in channel at Battery Island turn w. reduce flood

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/25/2018
Simulation #: 16
Pilot: Steve Phillips

3000' Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]
Time: *(Start)* 4:26 PM *(End)*
Channel Station: *(Start)* 850 *(End)* 1110
Direction of Transit: [✓ Inbound] / Outbound
Berth (docking/undocking only): BH1 LSW
Ship Model *(Piloted Vessel)*: CS13
Load Condition: PL3
Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*
Tug #2 *(Type/Power)*
Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts SW
Waves *(Hs / Tp / Dir)*: 1.5 m 8s 202.5m
Current *(stage / start time)*: Slack|flood 6:30 AM
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Stopped at Lower Swash
	Stayed within channel
	used full rudder full engine around battery island turn

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	[✓ 7]	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	[✓ 6]	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Assist tug at ADM on flood tide

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   Felt location of 3000' apex of battery island was typical protocol today with 8500 TEU but overall felt 4000' radius turn was more comfortable.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/25/2018
Simulation #: 17
Pilot: Steve Phillips

Outbound 4000' Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 5:06 PM *(End)*

Channel Station: *(Start)* 1170 SNM *(End)* 810 BH2

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5 m / 8s / 202.5

Current *(stage / start time)*: Slack / flood 6:30AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	@ 12:37 change environmental conditions to extreme – remove from data processing

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	[✓ 2]	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy: —

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Exclude data after ~12:37 of simulation
↳ changed conditions to extreme

8. Additional Commentary:

outbound easier than inbound.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 18
Pilot: Bill Hue

2 way passing - in River

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] LMN Design Layout #2 UMN

Time: *(Start)* 9:02 AM *(End)*

Channel Station: *(Start)* Lower Midnight 1400 *(End)* 1600

Direction of Transit: [✓ Inbound] / Outbound Piloted ship

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13 started LLP @ 1690 stop @ 1550 UMN

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW Layout 2 currents

Notes During Simulation:

Time Observations/Notes

Distance at passing btw ~230 ft
Stern of pilotted ship swung out was within ~55 ft of channel boundary

Pass on Upper Midnight @ 1550

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 [✓ 2] 3 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: —

   Tug Adequacy:

   Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   Expected to feel the passing ship more

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   Yes

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

- Pilots must be at equal speed.
- felt comfortable with 800 ft
- the auto pilot ship didn't yaw like the piloted

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1|26|2018
Simulation #: 19
Pilot: Bill Hue

TWO Way Passing - in River

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 9:35 AM *(End)*________ Channel Station: *(Start)* 1700 LLP *(End)* 1570 UMN

Direction of Transit: Inbound / [✓ Outbound] Pilot vessel Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13 Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13 started at LMN @ 1150 end @ UMN 1600

Available Tug Power:

Tug #1 *(Type/Power)*________

Tug #2 *(Type/Power)*________

Tug #3 *(Type/Power)*________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8 AM ↳ Layout 2 currents

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	270 Ft distance at pass
	Passed on upper midnigut @ 1600

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: [✓ 1] 2 3 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty: Autopilot going ~12.5 kts when passing, faster than desired

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   Thinks we can make the channel narrower

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 20
Pilot: Bill Hue

TWO Way Passing In River

Simulation Summary:

moved R Buoys in 75 ft
moved G Buoys in 25 ft
to try and simulate 700 ft channel

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 10:08 AM *(End)* ________

Channel Station: *(Start)* Lower midnight 1460 *(End)* 1600 UMN

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13 Started LLP 1690 Ended UMN 1550

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8 AM ↳ Layout 2

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

AP Ship at pass ~ 9 kts
Pilot Ship at pass ~ 8.8 kts

Pass @ Station 1580

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	[✓ 7]	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	[✓ 4]	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty: Didn't feel enough from the auto pilot and the bank.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   Hard to feel the 100 ft narrowing of channel, more auto pilot track rather than buoys

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 21
Pilot: Bill Hue

In River Two way Passing

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Auto Pilot track moved in 275ft on Green Side to simulate 700 ft channel width

Time: *(Start)* 10:45AM *(End)*

Channel Station: *(Start)* 1400 LMN *(End)* 1590 UMN

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13

Started: LLP 1090
Ended: UMN 1560

Available Tug Power:

Tug #1 *(Type/Power)*
Tug #2 *(Type/Power)*
Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 KTS SW
Waves *(Hs / Tp / Dir)*: —
Current *(stage / start time)*: Flood 8AM ↳ Layout # 2
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	~11 KTS Pilotted Ship
	Ship clearance at pass ~150 ft
	Stern ~75ft to channel boundary
	Passed @ 1580

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10
Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10
Run Difficulty *(10 is most difficult)*: 1 2 3 [✓ 4] 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Didn't feel enough from the passing
   Tug Adequacy: auto pilot ship or bank effect
   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   Felt that by moving auto pilot track
   felt the narrowing of the channel to 700 ft.

8. Additional Commentary:

   Less interaction btw ships than
   typical
   Within mile be on your side
   Once in critical spot can't correct
   pilot on each ship needs to be
   within a degree or two of their true

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 22
Pilot: Bill Hue

TWO way passing in RIVER

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2

Time: *(Start)* 11:20 *(End)* ________

Channel Station: *(Start)* 1450 LMN *(End)* 1630 UMN

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL1

Ship Model *(Passing Vessel)*: CS13 PL1 Started: 1710 LLP Ended: 1600 UMN

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Stern Left the channel on the turn from Lower to upper midnight, remained out/on the edge until R Buoy 36
	Passed @ 1610

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	[✓ 3]	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	[✓ 7]	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:
Tug Adequacy:
Difficulty:

- Would have stayed closer to the center at the start of the run
- Auto Pilot ship not tracking a good location

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Maintained for the most part would have started more in the center

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Over compensated for the auto pilot

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Would need more practice and would want tugs.

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Need more simulations where ship / ship interaction more realistic

3000

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 23
Pilot: Bill Hue

TWO way passing in River

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2 LMN UMN

Time: *(Start)* 12:15 *(End)*

Channel Station: *(Start)* 1460 *(End)* 1620

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 1

Ship Model *(Passing Vessel)*: CS13 PL 1 Start 1710 LLP
End 1590 UMN

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Auto Pilotted Ship Started at 12.7 kts to try and get the ship to keep speed w. the flood, however the AP Ship lost speed quickly still AP ship ~5.5 kt at passing

Pilot Ship at ~10 kt

Clearances:
Bow 173 ft
Center 125 ft

Passed @ 1600

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	[✓ 5]	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	[✓ 6]	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: No room for error.

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   With a lot more practice and restrictions

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   Missing the full effect of the banks and ship to ship interaction

8. Additional Commentary:

   Expected more ship/ship interaction

   Discussed – limiting to 2 way passing at 1 or 2 reaches

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 24
Pilot: Bill Hue

TWO Way Passing in RIVER

— Auto Pilot track moved in 275 ft on UMN RED Side to simulate 700 ft Channel width

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 12:53PM *(End)*

Channel Station: *(Start)* LLP 1700 *(End)* UMN 1570

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: CS 13

Start: LMN 1460
End: UMN 1590

Available Tug Power:

Tug #1 *(Type/Power)*
Tug #2 *(Type/Power)*
Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW
Waves *(Hs / Tp / Dir)*: —
Current *(stage / start time)*: Flood 8AM ↳ Layout 2
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Inbound Auto Pilot Ship transiting on upper midnight at 12 knots
	Pilot Ship transit 9.5 knots
	~160 ft btw ships at passing
	Passed @ 1580

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 [✓ 9] 10
Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10
Run Difficulty *(10 is most difficult)*: 1 2 3 [✓ 4] 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

   Very content with 700 ft channel.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 25
Pilot: Bill Hue

Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 1:19PM *(End)* ________

Channel Station: *(Start)* ________ *(End)* ________

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Bald Head Caswell Stern left channel
	Rudder and Engine stopped responding - crashed run

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 26
Pilot: Bill Hue

Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 1:48 PM *(End)*_______

Channel Station: *(Start)* BH3 770 *(End)* SNM 1200

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): _______

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*: _______

Available Tug Power:

Tug #1 *(Type/Power)*_______

Tug #2 *(Type/Power)*_______

Tug #3 *(Type/Power)*_______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5 m 8s 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	- Came closer to green side bald Head Caswell - taking the transit slower than simulation 25 which the software crashed. ~9/10 kts

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 [✓ 5] 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy:

Difficulty:

Go into the turns with the least amount of speed ~8/9 kts

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Wants the red buoy at apex of turn

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Similar trend from going to 5000 to 8500 TEU

Likes the 4000 radius

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 27
Pilot: Bill thue

Offshore Two way passing

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* Red *(End)*______

Direction of Transit: Inbound / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: ______

Load Condition: ______

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: ______

Waves *(Hs / Tp / Dir)*: ______

Current *(stage / start time)*: ______

Water Level: ______

Notes During Simulation:

Time	Observations/Notes
	This was testing for the two way passing offshore, the auto pilot did not follow the track

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 28
Pilot: Bill Hue

One Way in River Channel Width

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 3:54 PM *(End)* ________

Channel Station: *(Start)* SNM 1240 *(End)* RPT 1380

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kt SW

Waves *(Hs / Tp / Dir)*: ——

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW ↳ Layout 2

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 [✓ 4] 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Be sure to set up each turn

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   Turn going into Reaves Pt. came close to green side due to not paying attention

8. Additional Commentary:

   Willing to try the 400 ft wide channel.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/26/2018
Simulation #: 29
Pilot: Bill Hue

One way in river channel width

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2

Time: *(Start)* 4:25 PM *(End)* ________

Channel Station: *(Start)* SNM 1240 *(End)* RPT 1300

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL1

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 20kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	30 ft stern clearance going into horseshoe shoal range
	Left channel in horseshoe shoal coming from the turn from Snows marsh
	Ran aground going into Reaves Pt.
	↳ Crashed simulation upon grounding

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	[✓ 2]	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	[✓ 8]	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: 400 ft channel no room for
Tug Adequacy: error - have to set up perfectly
Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

If he got on the inside of turn/anywhere inside unable to correct.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

If you get out of the optium position yes

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

No

6. Please provide any comments on aids to navigation placement and range configurations:

Aids to navigation are hiderance

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Worst conditions given

8. Additional Commentary:

Extra width in the turn critical

400 ft width in straight away feels good.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1|26|2018
Simulation #: 30
Pilot: Bill Hue

one way in river channel width

Simulation Summary:

Simulation Layout: [✓ Existing Channel] Design Layout #1 Design Layout #2

Time: *(Start)* 4:50 PM *(End)* ________

Channel Station: *(Start)* SNM 1240 *(End)* RPT 1390

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL1

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)* ________

Tug #2 *(Type/Power)* ________

Tug #3 *(Type/Power)* ________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Left channel, stern coming into horseshoe shoal
	Using full speed, hard rudder to accomplish turn into Reaves Pt., stern left channel
	grounded in Reaves Point ↳ most likely due to speed and turning

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: [✓ 1] 2 3 4 5 6 7 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Can t make the turns inside

Tug Adequacy: the 400 ft channel.

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Up until after horseshoe Shoal turn maintain track afterwards couldn't set up second turn

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Yes coming around the turns Went hard rudder from side to side

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

No

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Doesn't think if we tone down the environmental conditions could make the turns

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 31
Pilot: Scott Aldridge

Offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: (Start) 9:20 AM (End) ______

Channel Station: (Start) OFF 360 (End) BH3 540

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model (Piloted Vessel): CS 13

Load Condition: PL 3

Ship Model (Passing Vessel): ______

Available Tug Power:

Tug #1 (Type/Power) ______

Tug #2 (Type/Power) ______

Tug #3 (Type/Power) ______

Environmental Conditions:

Wind (Speed / Direction): 20 kts SW

Waves (Hs / Tp / Dir): 1.5m / 8s / 202.5°

Current (stage / start time): Flood 6AM ↳ Layout 2

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	At beginning of run pilot forgot to set throttle
	Got close to green side of channel on offshore range

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety (10 is safest):	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy (10 is most adequate):	1	2	3	4	5	6	7	8	9	10
Run Difficulty (10 is most difficult):	1	[✓ 2]	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: The lack of throttle in the beginning

Tug Adequacy: affected ranking

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes, after the beginning where the pilot forgot to set throttle

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Set of inbound range on the new offshore channel range

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

The cross current and wind offset and negate each other.

The width offshore of 600 ft felt reasonable

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 32
Pilot: Scott Aldridge

offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 9:37 AM *(End)*

Channel Station: *(Start)* OFF 370 *(End)* BH3 530

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: NNE 20kts

Waves *(Hs / Tp / Dir)*: 1.5 m 8s 202.5

Current *(stage / start time)*: Flood 6AM ↳ layout 2

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Having to make leeway for the wind condition.

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 9 [✓ 10]

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: [✓ 1] 2 3 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: —

Tug Adequacy:

Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Range for inbound on new range

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

Width sufficient

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 33
Pilot: Scott Aldridge

Offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*_______ *(End)*_______

Channel Station: *(Start)* BH3 570 *(End)* OFF 450

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)*________

Tug #2 *(Type/Power)*________

Tug #3 *(Type/Power)*________

Environmental Conditions:

Wind *(Speed / Direction)*: NNE 20KTS

Waves *(Hs / Tp / Dir)*: 1.5 m 8s 202 5

Current *(stage / start time)*: Flood 6AM ↳Layout 2

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 [✓ 2] 3 4 5 6 7 8 9 10

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Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Unfamiliar turn

Tug Adequacy:

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Wants to re-evaluate G Buoy E

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

wasn't difficult but more difficult going into 600 ft from 900 ft than 600 ft into 900 ft.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 34
Pilot: Scott Aldridge

Offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 10:12 AM *(End)*

Channel Station: *(Start)* BH3 570 *(End)* OFF 470

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: SW 20 kts

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Flood 6AM ↳ layout 2

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	[✓ 2]	3	4	5	6	7	8	9	10

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Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: more familiar

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   Like the Location of Buoy E.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   Different winds wasn't noticable different
   wants to try true NE wind to get
   more the cross-current affect.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 35
Pilot: Scott Aldridge

Offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 10:29 AM *(End)*________

Channel Station: *(Start)* BH3 570 *(End)* OFF 450

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)*________

Tug #2 *(Type/Power)*________

Tug #3 *(Type/Power)*________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts NE

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Flood 6 AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	[✓ 2]	3	4	5	6	7	8	9	10

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Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy:

Difficulty:

Couple more degrees of adjustment needed w. NE wind.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

Sufficient widths of the two reaches

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 36
Pilot: Scott Aldridge

Offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)* 10:45 AM *(End)* ______

Channel Station: *(Start)* OFF 410 *(End)* BH3 620

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5 8s 202.5

Current *(stage / start time)*: Flood 6 AM

Water Level: MLLW ↳layout 2

Notes During Simulation:

Time	Observations/Notes
	at start heading quickly goes port side

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 [✓ 3] 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Difficulty came from the current

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   Inbound range, for offshore range
   markers

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise? More aware of the set in the turn, especially the stern

8. Additional Commentary:

   Felt comfortable with 600 ft to 600 ft assuming no 2 way passing in bald head shoal 3

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 37
Pilot: Scott Aldridge

Offshore new channel range

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)* 11:17 am *(End)*

Channel Station: *(Start)* OFF 410 *(End)* BH3 540

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*:

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 Kts NE

Waves *(Hs / Tp / Dir)*: 1.5 8s 202.5

Current *(stage / start time)*: Flood 6AM ↳ Layout 1

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	For all offshore inbound simulations the minute the simulation starts the ship goes to the port side
	For Bald Head Shoal 3 had to correct 2° to the NW of the centerline.

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	[✓ 7]	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	[✓ 3]	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Not uncommon to need 2-3° of leeway

Tug Adequacy:

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Moderate on Bald Head Reach 3
↳ think b/c of the NE wind.

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Believe the model is always diverting the ship to the Port at the start

8. Additional Commentary:

Feels good with widths assuming no 2-way passing on Bald Head Reach 3

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1|27|2018
Simulation #: 38
Pilot: Scott Aldridge

Offshore 1 way traffic - new channel range

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)* 11:35 AM *(End)*______ Channel Station: *(Start)* BH3 560 *(End)* OFF 420

Direction of Transit: Inbound / [✓ Outbound] Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13 Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 Kts NE

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Flood 10AM ↳ Layout 1

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Model Immediately set to Starboard

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	[✓ 6]	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	[✓ 4]	5	6	7	8	9	10

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Comparitively most challenging

Tug Adequacy: of these offshore simulations

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes - with constant adjustment for the leeway and drift.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Moderate drift based on wind and flood - realistic to today's conditions

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

No

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Dives to the starboard at the start outbound.

8. Additional Commentary:

Less comfortable with the width for Bald Head Reach 3

Speed is crucial to combat the environmental conditions, ~12/13 kts

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 39
Pilot: Scott Aldridge

Battery Island Turn - 4000 ft radius

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 12:05 *(End)* ______

Channel Station: *(Start)* BH3 770 *(End)* SNM 1160

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
12:33	Using full bow thruster to slow ship for ADM.

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	[✓ 6]	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	[✓ 7]	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: This was due to being
Tug Adequacy: unfamiliar, fist time with new
Difficulty: design and ATONs

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Not on the Southport range, 6° of leeway due to wind
wanted to be on the G side

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Excessive drift angle in Southport range

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes - with more simulations

6. Please provide any comments on aids to navigation placement and range configurations:

Southport Range and Lower Swash Range adjustments - Dennis denoting these changes

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Red Buoy at Battery Turn apex liked a lot

First look at the turn.

8. Additional Commentary:

Suggested assist tug for slowing down at ADM

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1|27|2018
Simulation #: 40
Pilot: Bill Hue
Scott Aldridge

Two Way Passing
Offshore

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______ Channel Station: *(Start)*______ *(End)*______

Direction of Transit: [✓ Inbound] Outbound Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: ______ Load Condition: ______

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20kts SW

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Flood 6AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Two manned ships
	-ended in collision-

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

    Safety:

    Tug Adequacy:

    Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

TWO Way Passing
Offshore

Date: 1|27|2018
Simulation #: 41
Pilot: Bill Hue - instructor
Scott Aldridge
↳ conning

Simulation Summary:

TWO PILOTS

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* BH3 520 *(End)* BH3 600

Direction of Transit: [✓ Inbound] / Outbound — conning

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13

Start BH3 640
End BH3 570

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Rising Flood 4:30 AM ↳ Layout 2

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Passed at: 590
	Clearence: ~240 ft

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 [✓ 3] 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Low currents

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   None

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

   Sufficient width for 2 way passing

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1|27|2018
Instructor Simulation #: 42
Pilot: Bill Hue + Scott Aldridge
conning

TWO Way Passing
TWO Pilots Offshore

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* BH3 520 *(End)* BH3 600

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: CS13

Start: BH3 640
End: BH3 570

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 KTS SW

Waves *(Hs / Tp / Dir)*: 1.5m 8s 202.5

Current *(stage / start time)*: Flood 6AM

Water Level: MLLW ↳Layout 2

Notes During Simulation:

Time	Observations/Notes
	Offshore target ship - pilot stopped manning controls after pass and therefore grounded.

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 [✓ 3] 4 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Effort to overcome the set inbound.

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes, outbound after pass stopped pay attention

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   Attention to outbound ship stopped after pass

8. Additional Commentary:

   900 ft feels good for width

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

TWO way Passing offshore

Date: 1/27/2018
Simulation #: 43
Pilot: Bill Hue + Scott Aldridge

Moved Buoys to Simulate 800 ft wide Offshore 2 way passing

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* BH3 520 *(End)* BH3 600

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13 PL3

Start: BH3 640 End: 570

2 way passing 2 pilots

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5 m 8s 202.5

Current *(stage / start time)*: Flood 6AM

Water Level: MLLW ↳Layout 2

Notes During Simulation:

Time	Observations/Notes
	Passed @ 585

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 [✓ 4] 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: —

Tug Adequacy:

Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

No Ship/Ship interaction

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Comfortable with 800 ft wide channel Bald Head Reach 3

8. Additional Commentary:

Consider 700 – 750 ft width
↳ evaluate in future testing

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 44
Pilot: Bill Hue

One Way Transit Width

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

moved Buoys 25 ft in on both sides of channel to simulate 450 ft wide channel added three red buoys

Time: *(Start)* 2:30 PM *(End)*

Channel Station: *(Start)* SNM 1240 *(End)* RPT 1380

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only):

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*:

Evaluating 1 way transit width

Available Tug Power:

Tug #1 *(Type/Power)*

Tug #2 *(Type/Power)*

Tug #3 *(Type/Power)*

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8AM ↳ Layout 2

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	[✓ 6]	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	[✓ 6]	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: A lot of environmental conditions

Tug Adequacy:

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)* Turn into Reaves Pt Range stern swung out.

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Would need more testing, and the actual channel boundaries - possibility

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

wants bend widd

8. Additional Commentary:

Thinks 450 ft in straightaways is sufficient with the desire for additional testing

Wants 500 ft in the turns, with 450 ft no room for error in the turns

450 ft turns make it tight

↳ hard to judge without updating line work

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 45
Pilot: Bill Hue

One way transit width

Simulation Summary:

moved buoys 25 ft in on both sides of channel to simulate 450 ft wide channel
added 3 red buoys

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*________

Channel Station: *(Start)* RPT 1440 *(End)* SNM 1260

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): ____________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ____________

Evaluating 1 way transit width

Available Tug Power:

Tug #1 *(Type/Power)*____________

Tug #2 *(Type/Power)*____________

Tug #3 *(Type/Power)*____________

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 8AM ↳ Layout 2

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 [✓ 6] 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: - With opposing current didn't
Tug Adequacy: have the concern of being swept
Difficulty: through the turn

At Green 27 desires bend widener for additional width

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

With additional width at G27
and more simulations

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

450 ft width plausible in straightaways
need at least 500 ft width in turns

8. Additional Commentary:

At Green Buoy 27 it would be advisble
to have bend widener

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 46
Pilot: Scott Aldridge

Battery Island Turn
3000' radius

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* ~~780~~ BH3 *(End)* ~~1150~~ SNM

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 Kts SW

Waves *(Hs / Tp / Dir)*: 1.5m/8s/202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	High rate of turn and a lot of rudder to make the turn at Battery Island

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 [✓ 6] 7 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 [✓ 6] 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Unfamiliar, first time

Tug Adequacy: seeing 3000 ft radius

Difficulty: Southport Range burden due to environmental conditions

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Ideally closer to the green side in Southport range.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Moderate to excessive in Southport Range

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Bald Head Reach | Range→markers needs to be centered
Smith Island Range
Apex Red Buoy very helpful.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

more rudder needed than 4000 ft radius

8. Additional Commentary:

Suggest an assist tug at ADM

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/27/2018
Simulation #: 47
Pilot: Scott Aldridge

Battery Island Turn - 4000' Radius

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* Southport 970 *(End)*______

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: 20kts SW

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Ran starting @ Southport Range - due to time constraints of pilot

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	[✓ 3]	4	5	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: Started With Ideal Starting position on green side of southport.

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

   —

8. Additional Commentary:

   Never felt like he maxed out the ship, which he felt on the 3000 ft radius

   Perfers the 4000 ft turn

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 48
Pilot: Jason McDowell

Familiarization - Battery Island turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 8:44am *(End)*________

Channel Station: *(Start)* BH3 750 *(End)* LSW 1120

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ________

Available Tug Power:

Tug #1 *(Type/Power)*________

Tug #2 *(Type/Power)*________

Tug #3 *(Type/Power)*________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts SW

Waves *(Hs / Tp / Dir)*: 1.5 m | 8s | 202.5

Current *(stage / start time)*: Rising Flood 6:30 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Stern left at Bald Head Caswell turn into Southport - was using full rudder ~8 kts SOG
	Stern left channel in Battery Island turn - was using full rudder ~10 kts SOG

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	[✓ 7]	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	[✓ 5]	6	7	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:
Tug Adequacy:
Difficulty:

Familiarization with simulator and seeing the design turn for the first time

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

At buoy 15 felt it was excessive would have thought he would have felt it at 13

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Thought rudder response was slow but also getting familiar with ship.

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes - with more practice

6. Please provide any comments on aids to navigation placement and range configurations:

Undecided on ATON wants another run

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Thought that was room for error with the 4000 ft radius.

- Suggest assist tug for ADM

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 49
Pilot: Jason McDowell

Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 9:31 *(End)* ______

Channel Station: *(Start)* BH 3 750 *(End)* LSW 1110

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL 3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 Kts SW

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Rising flood 6:30AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

- Was able to stay inside at Bald Head Caswell
- Hard to brake habit of the Battery Island Turn where the pilot is incline to be on the green side of turn
- Left the channel with the stern in Battery Island turn apex

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 [✓ 5] 6 7 8 9 10

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Simulation Summary, Notes, & Pilot Evaluation
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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: To keep it in the channel at 15

Tug Adequacy: made it so he wasn't able to

Difficulty: set up Battery Island Turn as desired.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

Little at Buoy 15

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes – felt more comfortable since the familiarization run

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Struggled to see new red buoy but liked the concept.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 50
Pilot: Jason McDowell

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)* 10:20 AM *(End)* ______

Channel Station: *(Start)* BH3 750 *(End)* LSW 1110

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: SW 20 kts

Waves *(Hs / Tp / Dir)*: 1.5m/8s/202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Stern left channel ever so slightly during battery island turn

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	[✓ 10]
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	[✓ 3]	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Feels more familiar each time

Tug Adequacy:

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Felt comfortable the 4000 ft turn radius

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 51
Pilot: Jason McDowell

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 [✓ Design Layout #2]

Time: *(Start)* 11 AM *(End)* ______

Channel Station: *(Start)* BH3 780 *(End)* LSW 1110

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: ______

Load Condition: ______

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5m | 8s | 202.5

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	[✓ 5]	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy: —

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No.

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Noticable difference btw the 2 turn radius - 3000 ft is in the area of typical transit currently but had to max out the rudder, 3000 ft no room for error, when 4000 ft has the ability to correct as needed.

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Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 52
Pilot: Jason McDowell

2 way Passing - in River

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* LMN 1460 *(End)* LLP 1650

Direction of Transit: [✓ Inbound] - Pilot Ship / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13 PL3

Started: LLP 1700
Ended: UMN 1550

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: WEST 15 kt

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Pilot ship going 14 kts during pass

Auto Pilot ship ~ 9 kts during pass

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 9 [✓ 10]

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 8 9 10

Run Difficulty *(10 is most difficult)*: 1 2 [✓ 3] 4 5 6 7 8 9 10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy:

Difficulty:

Thinks he would have slowed to 10/12 kts and then come ahead during the pass

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

—

8. Additional Commentary:

Thinks the width is adequate

Is open to the idea of a 700 ft channel.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 53
Pilot: Jason McDowell

2 way Passing - in River

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* LLP 1090 *(End)* UMN 1540

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13 PL3 Started LMN 1450
Ended UMN 1600

Available Tug Power:

Tug #1 *(Type/Power)*______

Tug #2 *(Type/Power)*______

Tug #3 *(Type/Power)*______

Environmental Conditions:

Wind *(Speed / Direction)*: W 15 kt

Waves *(Hs / Tp / Dir)*: 1.5 m / 8 s / 202.5

Current *(stage / start time)*: Flood 8AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	[✓ 3]	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: was feeling the west wind

Tug Adequacy: more going outbound

Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Felt the 800 width was more than adequate

- would be open to simulate 700 ft width -

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Date: 1/29/2018
Simulation #: 54
Pilot: Jason McDowell

Battery Island Turn

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* SNM 1100 *(End)* BH2 810

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* ______

Tug #2 *(Type/Power)* ______

Tug #3 *(Type/Power)* ______

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kt NNE

Waves *(Hs / Tp / Dir)*: 1.5m / 8s / 202.5

Current *(stage / start time)*: Rising Flood 6:30 AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	[✓ 2]	3	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

    Safety: —

    Tug Adequacy:

    Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

    Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

    No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

    Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

    Yes

6. Please provide any comments on aids to navigation placement and range configurations:

    Last Red Coast Guard Beacon used as reference they are all on piles.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

    Outbound easier than inbound
    ↳ substantially

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
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Date: 1/29/2018
Simulation #: 55
Pilot: Jason McDowell

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*____ *(End)*____ Channel Station: *(Start)* SNM ~~1100~~ *(End)* BH3 790

Direction of Transit: Inbound / [✓ Outbound] Berth (docking/undocking only): ____

Ship Model *(Piloted Vessel)*: CS13 Load Condition: PL3

Ship Model *(Passing Vessel)*: CS13

Available Tug Power:

Tug #1 *(Type/Power)*____

Tug #2 *(Type/Power)*____

Tug #3 *(Type/Power)*____

Environmental Conditions:

Wind *(Speed / Direction)*: 20 kts SW

Waves *(Hs / Tp / Dir)*: 1.5 m / 8 s / 202.5

Current *(stage / start time)*: Flood 8 AM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	[✓ 10]
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	[✓ 2]	3	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: —

Tug Adequacy:

Difficulty: —

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

No real difference btw wind and current with simulation 54

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Simulation Summary, Notes, & Pilot Evaluation
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PORT

Date: 1/29/2013
Simulation #: 56
Pilot: Glenn Turbeville

Operating: Gwen + Glen Watch: Jerry + Dennis

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 Design Layout #2

Time: *(Start)*_______ *(End)*_______ Channel Station: *(Start)*_______ *(End)*_______

Direction of Transit: Inbound / Outbound Berth (docking/undocking only): _______

Ship Model *(Piloted Vessel)*: _______ Load Condition: _______

Ship Model *(Passing Vessel)*: _______

Available Tug Power:

Tug #1 *(Type/Power)*_______

Tug #2 *(Type/Power)*_______

Tug #3 *(Type/Power)*_______

Environmental Conditions:

Wind *(Speed / Direction)*: _______

Waves *(Hs / Tp / Dir)*: _______

Current *(stage / start time)*: _______

Water Level: _______

Notes During Simulation:

Time	Observations/Notes
	Docking Familiarization

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

    Safety:

    Tug Adequacy:

    Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

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PORT

Date: 1/29/2018
Simulation #: 57
Pilot: Glenn Turbeville

Operate: Gwen + Glen Watch: Jerry + Dennis

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* FEJ 2170 *(End)* TB ↳ grounded

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: ______

Load Condition: ______

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* 53
Tug #2 *(Type/Power)* 53
Tug #3 *(Type/Power)* 32
Tug #4 32

Environmental Conditions:

Wind *(Speed / Direction)*: ↑
Waves *(Hs / Tp / Dir)*: 15 kts NE
Current *(stage / start time)*: Slack 7AM
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Started Ship @ zero knots
	grounded bow on West Side of turning basin - stopped run

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	7	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety:

   Tug Adequacy:

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

6. Please provide any comments on aids to navigation placement and range configurations:

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

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PORT

Date: 1/29/2018
Simulation #: 58
Pilot: Glen Turberville

Operating: Gwen & Glen Watching: JERRY + DENNIS

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

FEJ Twins

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* 2170 *(End)* grounded at Berth 5

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______

Ship Model *(Piloted Vessel)*: ______

Load Condition: ______

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* 53
Tug #2 *(Type/Power)* 53
Tug #3 *(Type/Power)* 32
Tug #4 32

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts NE
Waves *(Hs / Tp / Dir)*: —
Current *(stage / start time)*: Slack 7AM
Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Started ship @ zero knots
	Steering lost from conning station + engine ↳ doing by mouse clicking
	made turn successfully in the turning basin
	grounded on green side after the turn going into berth

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	[✓ 6]	7	8	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	[✓ 7]	8	9	10

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Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Excluding the grounding at the
Tug Adequacy: end.
Difficulty: Difficult for conventional tugs

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

No, at the Slower Speeds trickly

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

No – unsure if it is the model or pilot
↳ needs more testing

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

In talking with Docking Pilot 75ft
expansion Critical to have.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/29/2018
Simulation #: 59
Pilot: Glen Tuberville

Operating: Gwen + Glen   Watching: Jerry + Dennis

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*________

Channel Station: *(Start)* Btw channel 2230 *(End)* Turning Basin

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): ______________

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ________________

Available Tug Power:

Tug #1 *(Type/Power)*____________________

Tug #2 *(Type/Power)*____________________

Tug #3 *(Type/Power)*____________________

Environmental Conditions:

Wind *(Speed / Direction)*: 15kts SW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Flood 9:30 AM

Water Level: MLLW

Notes During Simulation:

Time   Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	[✓ 9]	10
Run Difficulty *(10 is most difficult)*:	1	2	[✓ 3]	4	5	6	7	8	9	10

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Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: More familiar with simulator

   Tug Adequacy: More comfortable on where to turn

   Difficulty: Flood tide helping

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No felt accurate

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

   Thinks the width is sufficient, incline to think need 1000 ft both west + east side, west side fills in first when dredging gets behind.

Operating: Gwen + Glen

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Watching: Randy, Dennis, Jerry

Date: 1/30/2018
Simulation #: 60
Pilot: Glen Tuberville

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* FEJ 2170 *(End)* Berth 8 FEJ 2200

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): Berth 8

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* 53

Tug #2 *(Type/Power)* 53

Tug #3 *(Type/Power)* 32

Tug #4 32

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts NE

Waves *(Hs / Tp / Dir)*: ——

Current *(stage / start time)*: Slack 7:00 AM

Water Level: MLLW

Notes During Simulation:

* note dock pilot typical takes over at Buoy 58

Time	Observations/Notes
	Uses the bridge as point of reference — be sure to include for future testing.
	Full tug power in turn using bow thrusters
	- Would have had center lead stern tug be able to push and pull starboard quarter

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 7 8 [✓ 9] 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 [✓ 4] 5 6 7 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy: If had problem with one conventional tugs went still think we would be okay

Difficulty: → Due to all the berthed ships

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes for the most part
coming back to berth, hard to maintain steering

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No - felt accurate.

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

-

Thinks potential issue with berth going to shallow that you will basically have to push against a bulkhead

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

Thinks it is the draft and beam not the length that is challenging.

⊛ Critical for design to move old ashpalt terminal

8. Additional Commentary:

Likes to use full power to get the momentum - then be able to ease

Has different alternatives if tug isn't avilable

Basically turning a dead ship.

5-6 start/stops

Randy
Tug Capta
&
[illegible]king
Pilot

Operating: Gwen + Glen

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Watching: Randy, Dennis
Present: Jerry

Date: 1/30/2018
Simulation #: 61
Pilot: Glen Tuberville

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2 FEJ 2220

Time: *(Start)*_______ *(End)*_______

Channel Station: *(Start)* FEJ 2170 *(End)* BERTH 8

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): Berth 8

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: _______

Available Tug Power:

Tug #1 *(Type/Power)*_______

Tug #2 *(Type/Power)*_______

Tug #3 *(Type/Power)*_______

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts SW

Waves *(Hs / Tp / Dir)*: ——

Current *(stage / start time)*: Flood 9:30AM

Water Level: MLLW

Notes During Simulation:

Time | Observations/Notes

Rontinely having clearences today of ~70 ft to channel limits

With 41 ft pulling a lot of water with how narrow the channel is past port of willmington

center Light in center of existing basin will need to be moved, currently on North end of moved trellis

If the wind is blowing down the river the dock pilot is going higher up the basin

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Run Difficulty *(10 is most difficult)*:	1	2	3	4	[✓ 5]	6	7	8	9	10

* went forward twice in the turn *
using Dead Slow

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety:

Tug Adequacy: Tug positioning still up for debate

Difficulty: Let the ship run a little more then he has in previous runs.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes - would utlize the tug at 45° more than he did in the run.

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No - accurate.

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Felt like expected as started, he had to work on Starbrard quarter a little more

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

Will have to move center of the TB light to true center, raise A + B TB lights, critical use of the bridge.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

1000 ft drift angle needed on both sides.

8. Additional Commentary:

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/30/2018
Simulation #: 62
Pilot: Glen Tuberville

Operating: Glen + Gwen Present: Jerry + Dennis Watching: Randy

Simulation Summary:

Simulation Layout: Existing Channel Design Layout #1 Design Layout #2

Time: *(Start)*______ *(End)*______

Channel Station: *(Start)* Berth 8 *(End)* FEJ 2180

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): Berth 8

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ______

Available Tug Power:

Tug #1 *(Type/Power)* 53

Tug #2 *(Type/Power)* 53

Tug #3 *(Type/Power)* ______

Pilot said these would be the worst condition

Environmental Conditions:

Wind *(Speed / Direction)*: NW 15kts

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Ebb 3:30 PM

Water Level: MLLW

Notes During Simulation:

Time	Observations/Notes
	Always has the bow get very close to dock
	Stern slightly left channel on green side

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 [✓ 5] 6 7 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Coming off the dock felt as expected,
Tug Adequacy: didn't get pushed back on dock as
Difficulty: anticipated with the NW wind

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

No – Thought Stern would go closer to berth 9

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

No – less than expected

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

No – Coming off the berth yes, once started coming ahead – NO

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

remove green 61 completely.

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

Felt comfortable overall.

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/30/2018
Simulation #: 63
Pilot: Glen

Operating: Glen + Gwen Watching: Randy + Jerry

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2

Time: *(Start)*____ *(End)*____

Channel Station: *(Start)* Berth 8 *(End)* FEJ 2180

Direction of Transit: Inbound / [✓ Outbound]

Berth (docking/undocking only): Berth 8

Ship Model *(Piloted Vessel)*: CS13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ____

Available Tug Power:

Tug #1 *(Type/Power)*____

Tug #2 *(Type/Power)*____

Tug #3 *(Type/Power)*____

Environmental Conditions:

Wind *(Speed / Direction)*: 15 kts NW

Waves *(Hs / Tp / Dir)*: —

Current *(stage / start time)*: Ebb 3:30 PM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*:	1	2	3	4	5	6	7	[✓ 8]	9	10
Tug Adequacy *(10 is most adequate)*:	1	2	3	4	5	6	7	8	9	[✓ 10]
Run Difficulty *(10 is most difficult)*:	1	2	3	4	5	6	[✓ 7]	8	9	10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

   Safety: will keep tugs attached longer than presently do.

   Tug Adequacy: Keep tugs until clear of berth 9

   Difficulty:

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

   Yes

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

   No

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

   Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

   Yes

6. Please provide any comments on aids to navigation placement and range configurations:

   —

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

   overall felt good

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Date: 1/30/2018
Simulation #: 64
Pilot: Glen

Operating: Gwen & Glen Watching: Jerry & Randy

Simulation Summary:

Simulation Layout: Existing Channel [✓ Design Layout #1] Design Layout #2 FEJ 2220

Time: *(Start)*_______ *(End)*_______

Channel Station: *(Start)* FEJ 2170 *(End)* Berth 8

Direction of Transit: [✓ Inbound] / Outbound

Berth (docking/undocking only): BERTH 8

Ship Model *(Piloted Vessel)*: CS 13

Load Condition: PL3

Ship Model *(Passing Vessel)*: ________________

Available Tug Power:

Tug #1 *(Type/Power)*________________

Tug #2 *(Type/Power)*________________

Tug #3 *(Type/Power)*________________

Environmental Conditions:

Wind *(Speed / Direction)*: 15 Kts NE

Waves *(Hs / Tp / Dir)*: ——

Current *(stage / start time)*: Ebb 3:30 PM

Water Level: MLLW

Notes During Simulation:

Time Observations/Notes

Pilot thought the ship was checking up nicely past PW w/o any tug power going into the TB.

Stern clearance ~40 ft East side of turning basin

* used up to half engine during turn when stern is parallel to east

Summary Ratings for Safety, Tug Adequacy, and Difficulty:

Run Safety *(10 is safest)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

Tug Adequacy *(10 is most adequate)*: 1 2 3 4 5 6 7 [✓ 8] 9 10

Run Difficulty *(10 is most difficult)*: 1 2 3 4 5 6 [✓ 7] 8 9 10

9232-06 Cape Fear River Navigation Simulations
Simulation Summary, Notes, & Pilot Evaluation
Wilmington, NC

Post Simulation Review/Debrief:

1. Any qualification regarding the simulation summary ratings?

Safety: Center lead aft Would need to
Tug Adequacy: use for steering – which he did not
Difficulty: anticipate.

2. Were you able to maintain the intended track line and voyage plan on this exercise? (If not, why?)

Yes & no – once employed center lead aft tug yes making approach to berth

3. Was the drift angle or swept path excessive in certain areas? *(If so, what was causing the excessive drift angle / swept path?)*

NO

4. Did the ship model react as expected with the given environmental conditions? If not, what was different?

Yes

5. Would you perform a similar transit / maneuver in a real-world situation? If not, why?

Yes

6. Please provide any comments on aids to navigation placement and range configurations:

—

7. Are there any extenuating circumstances that should be taken into account when examining the results of this simulation exercise?

8. Additional Commentary:

With ebb tide minimum 4 tugs –
4 tugs was adequate.

Appendix B–4:
Simulation Swept Path Summary Figures

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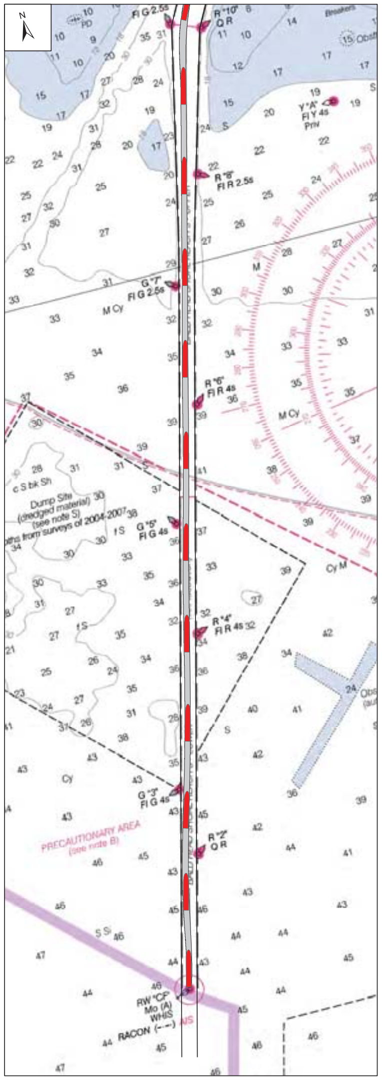
(continued on panel 2)



Simulation #5 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]

🟩 <= 6.0
🟩 6.1 - 8.0
🟨 8.1 - 10.0
🟧 10.1 - 12.0
🟥 > 12.0

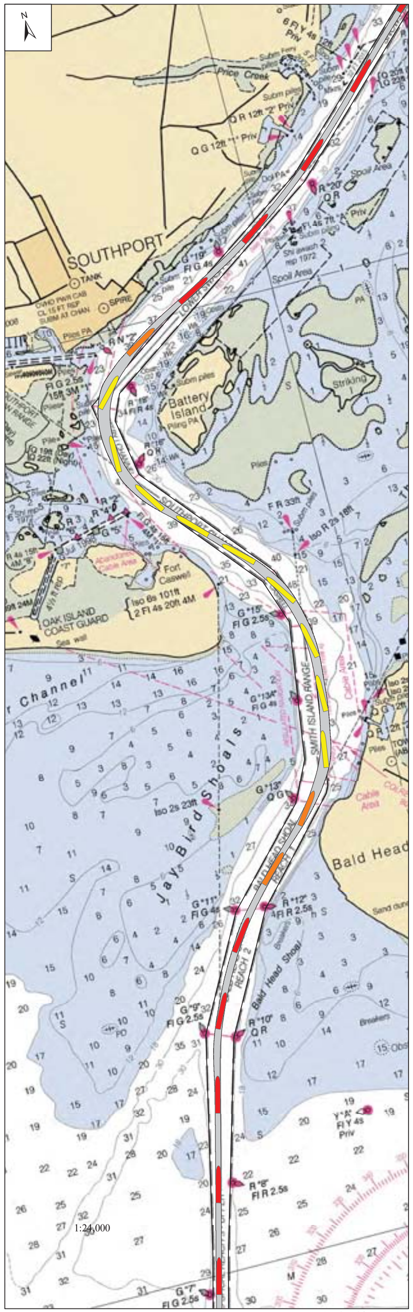
▬ Swept Path Envelope
— Existing Channel

0 2,000 4,000 Feet

1 in = 2,000 feet (when printed 34" x 22")

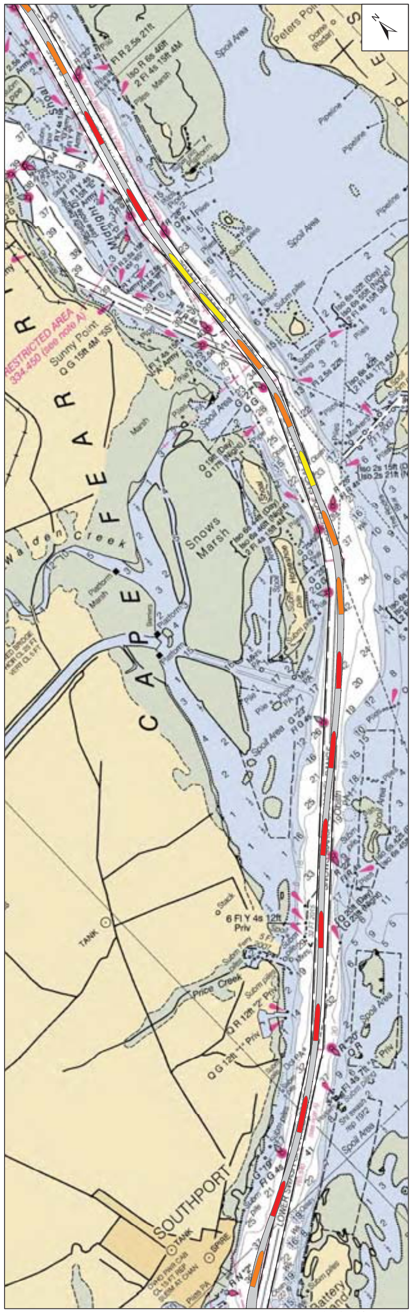
Note: North is rotated counterclockwise by 14°, 14°, & 43°, for panels 1, 2, & 3, respectively.

(continued on panel 3)



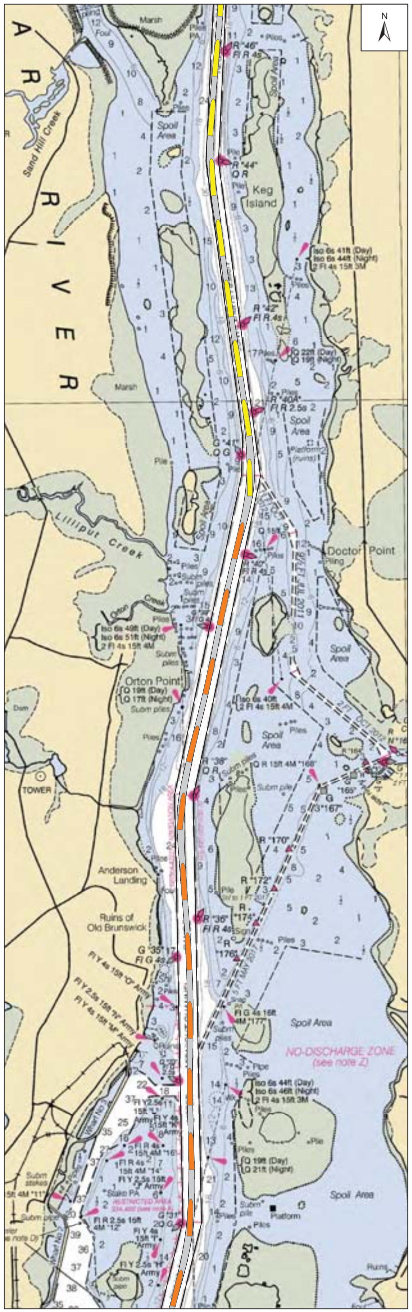
(continued from panel 1)

(continued on panel 4)



(continued from panel 2)

(continued on panel 5)



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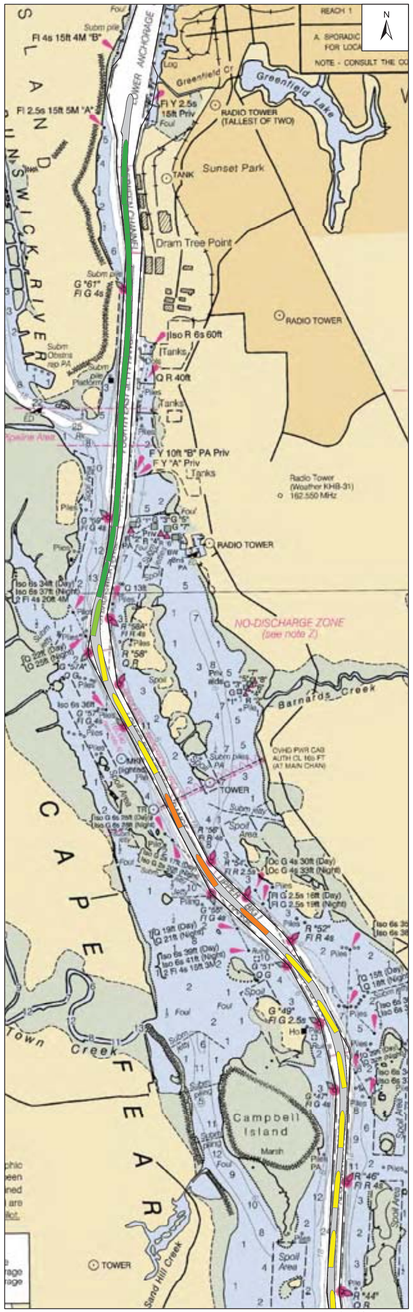

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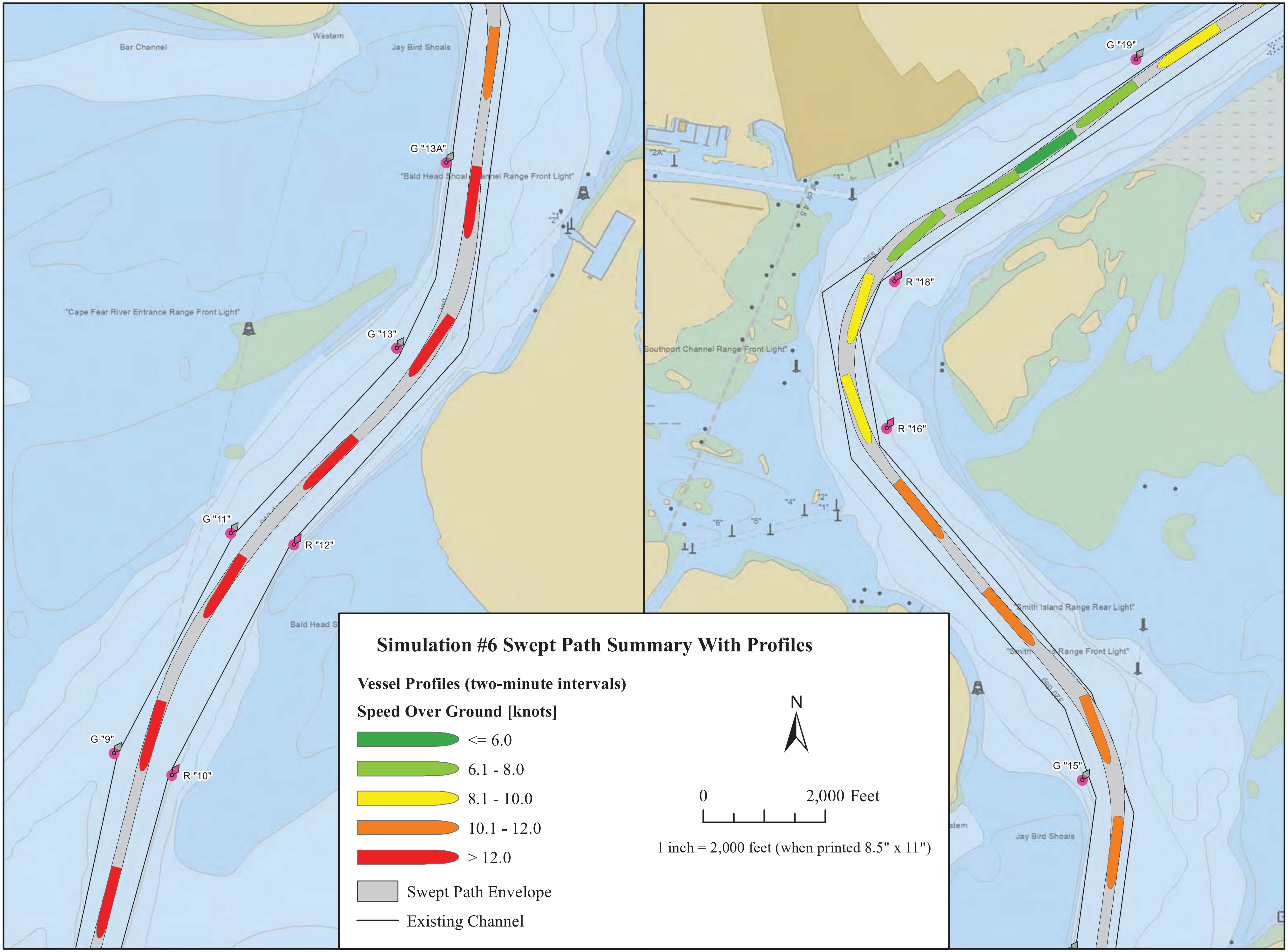
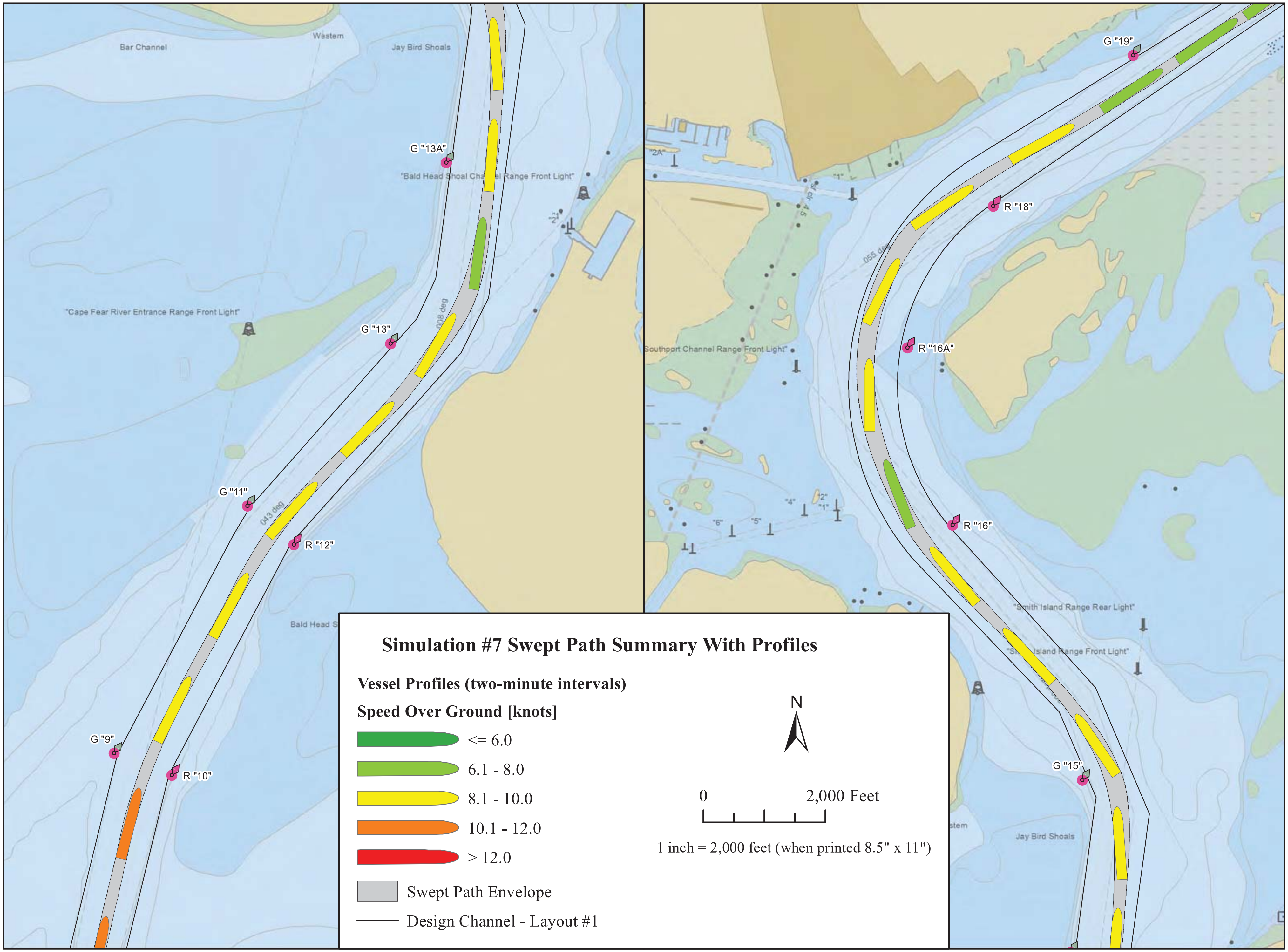
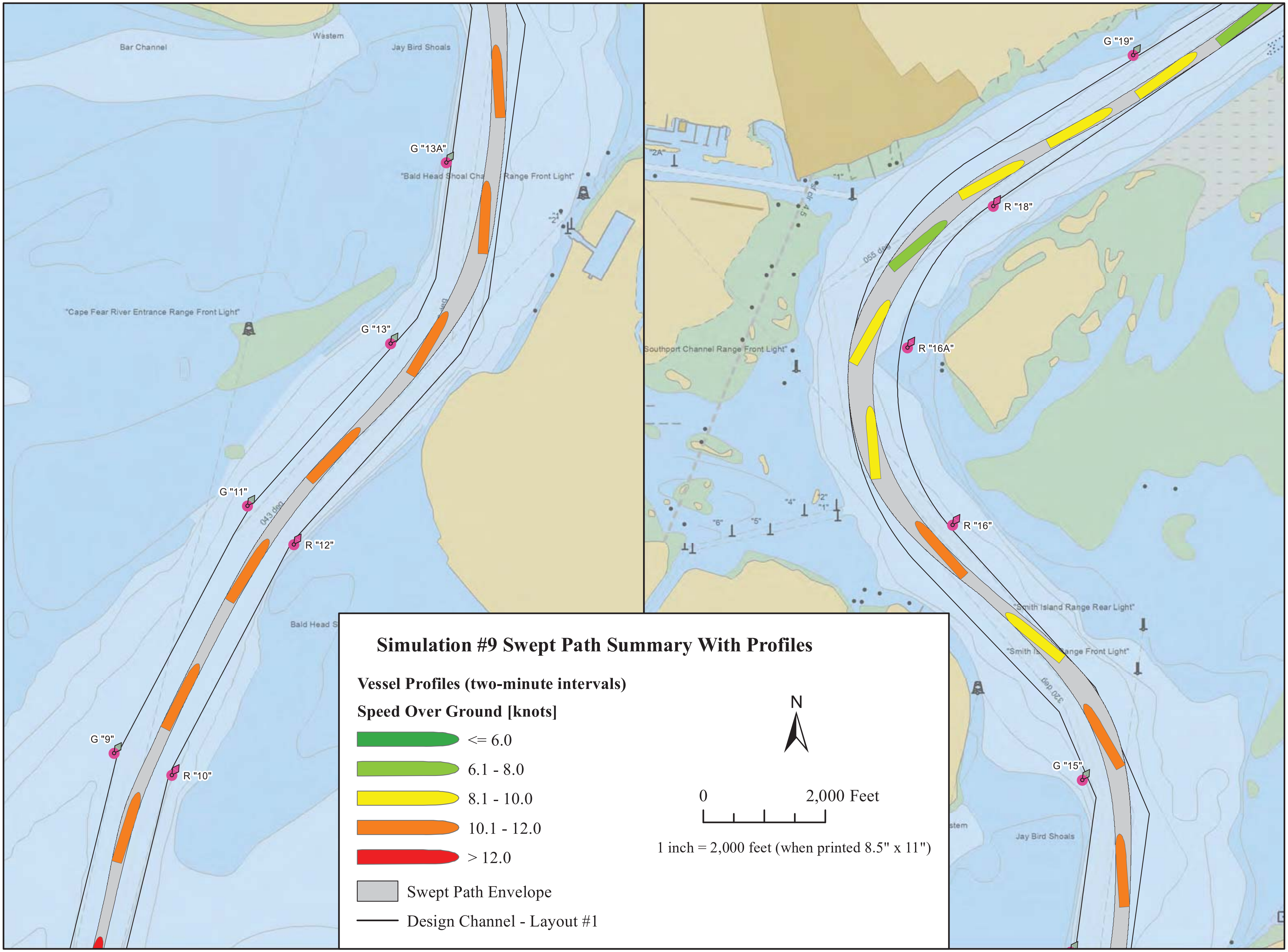


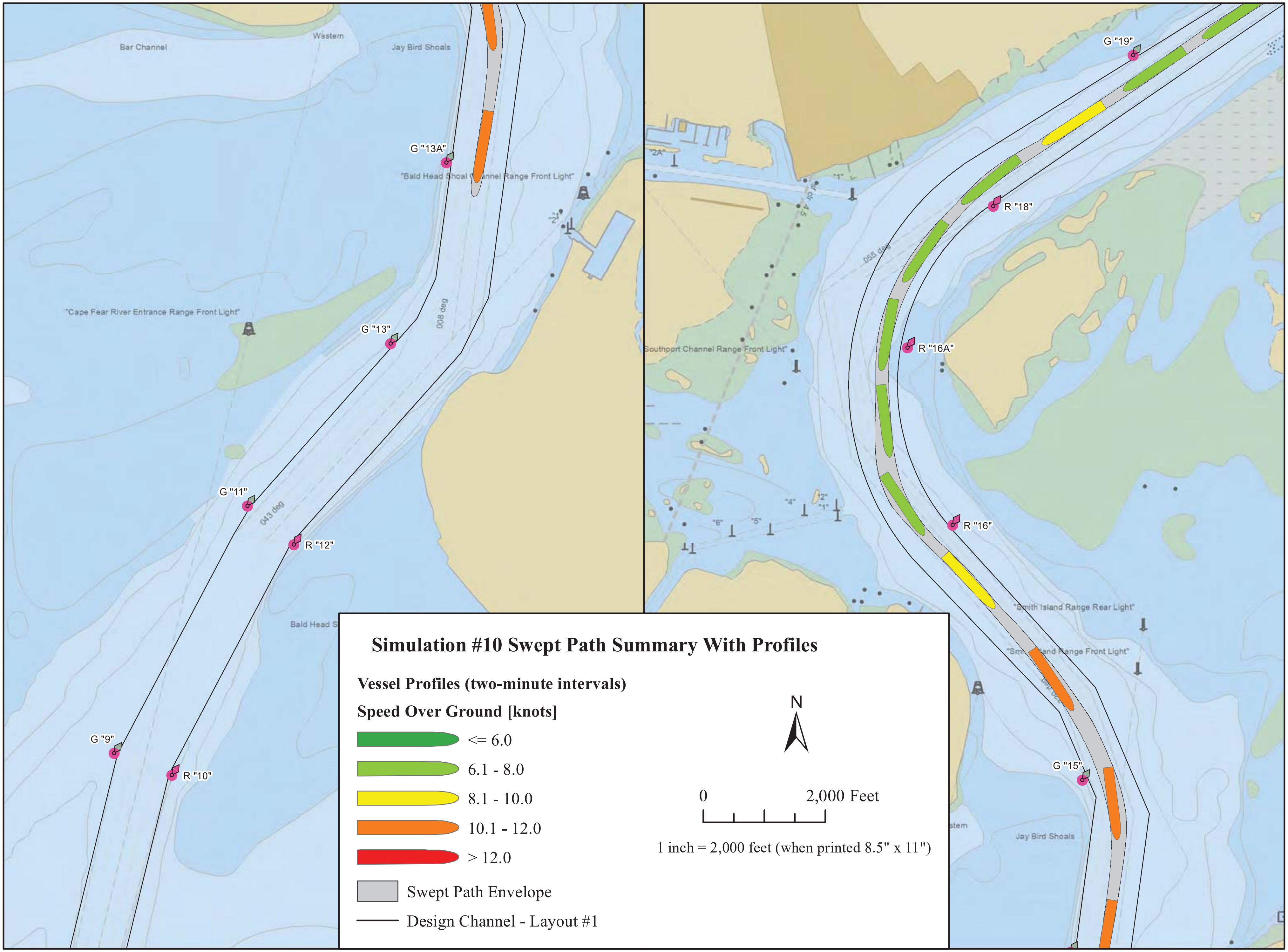
Simulation #6 Swept Path Summary With Profiles



Simulation #7 Swept Path Summary With Profiles



Simulation #9 Swept Path Summary With Profiles



Simulation #10 Swept Path Summary With Profiles

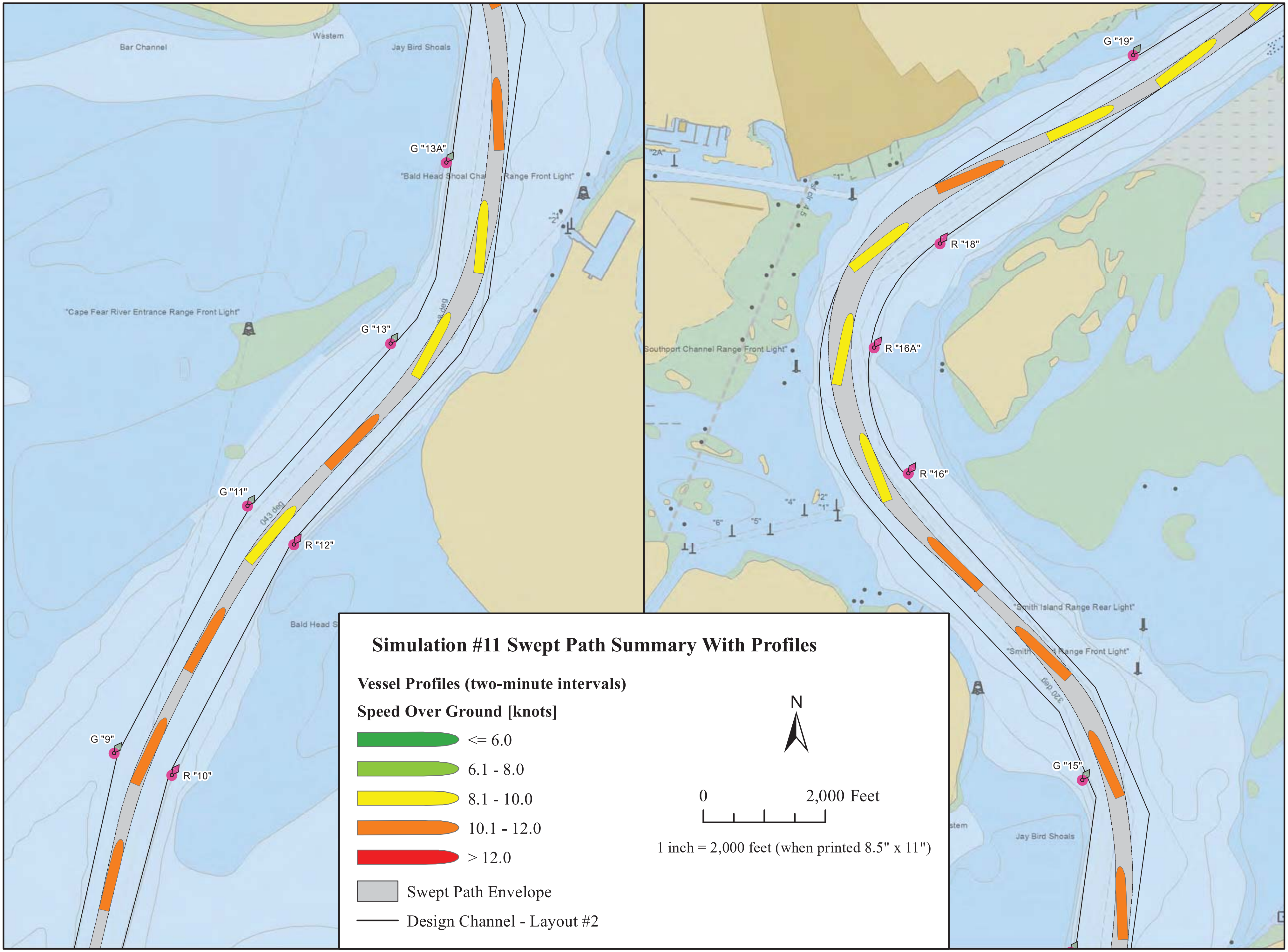
Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

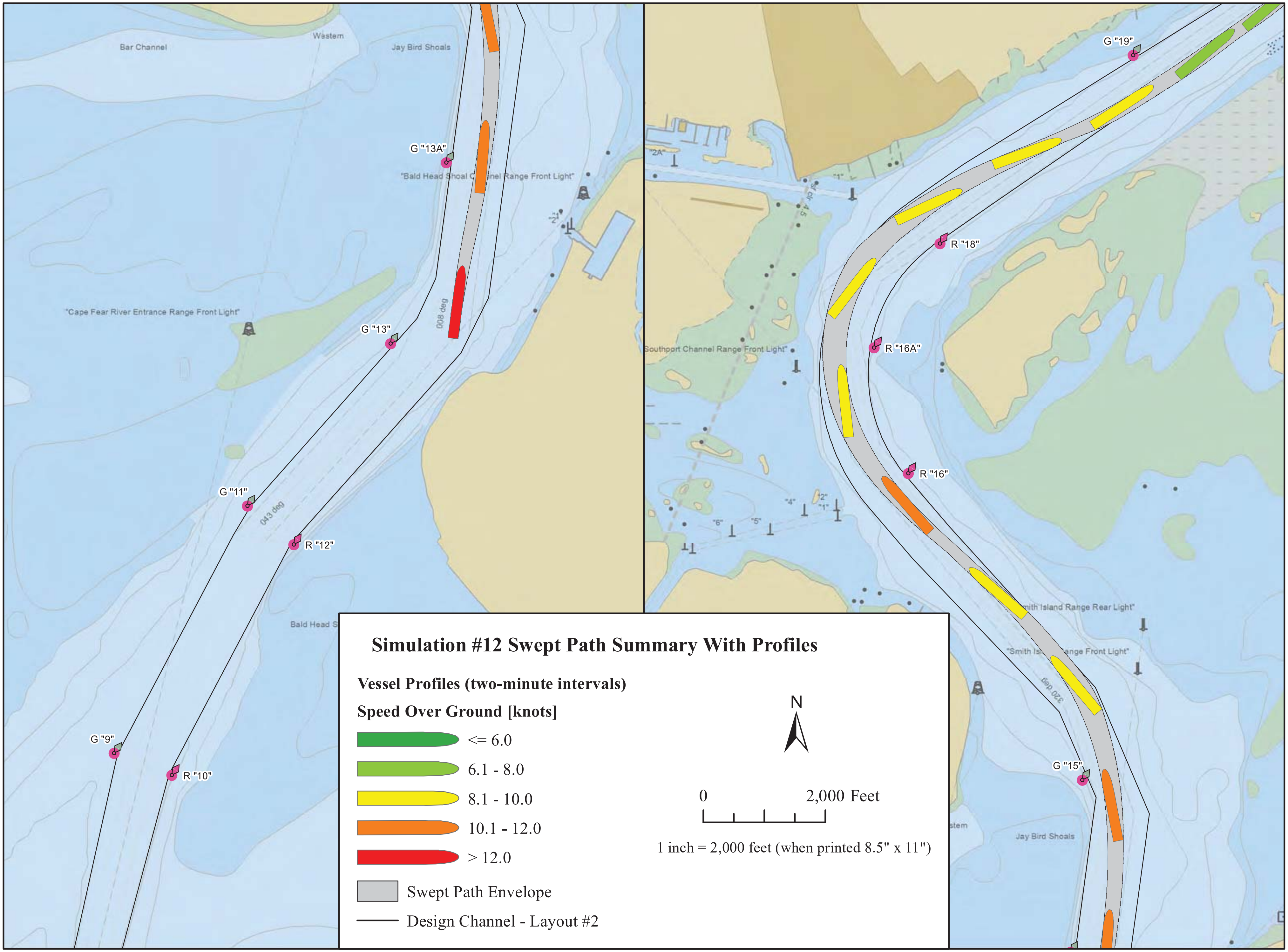
🟩	<= 6.0
🟩	6.1 - 8.0
🟨	8.1 - 10.0
🟧	10.1 - 12.0
🟥	> 12.0
⬜	Swept Path Envelope
—	Design Channel - Layout #1

0 2,000 Feet

1 inch = 2,000 feet (when printed 8.5" x 11")



Simulation #11 Swept Path Summary With Profiles

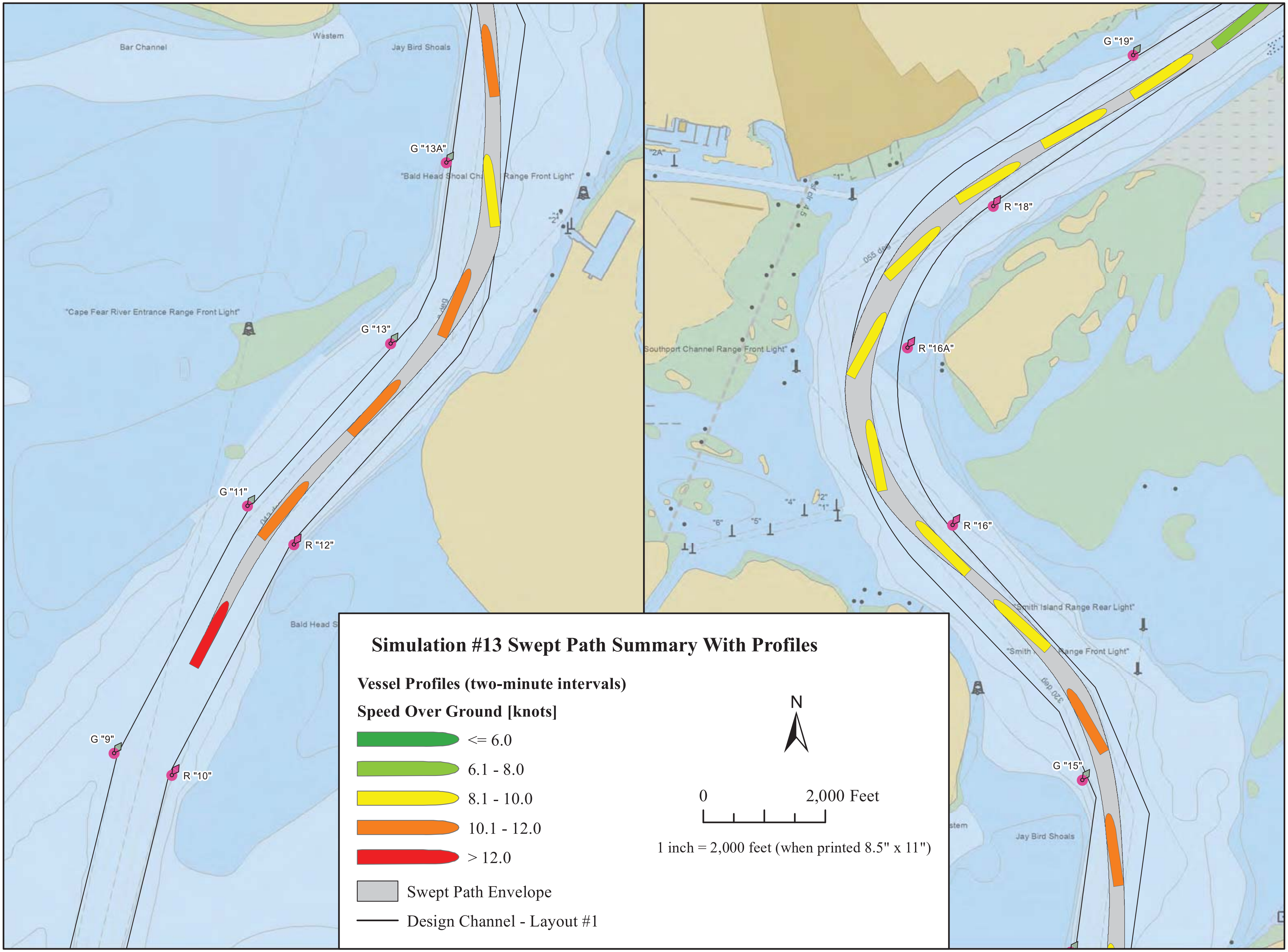


Simulation #12 Swept Path Summary With Profiles

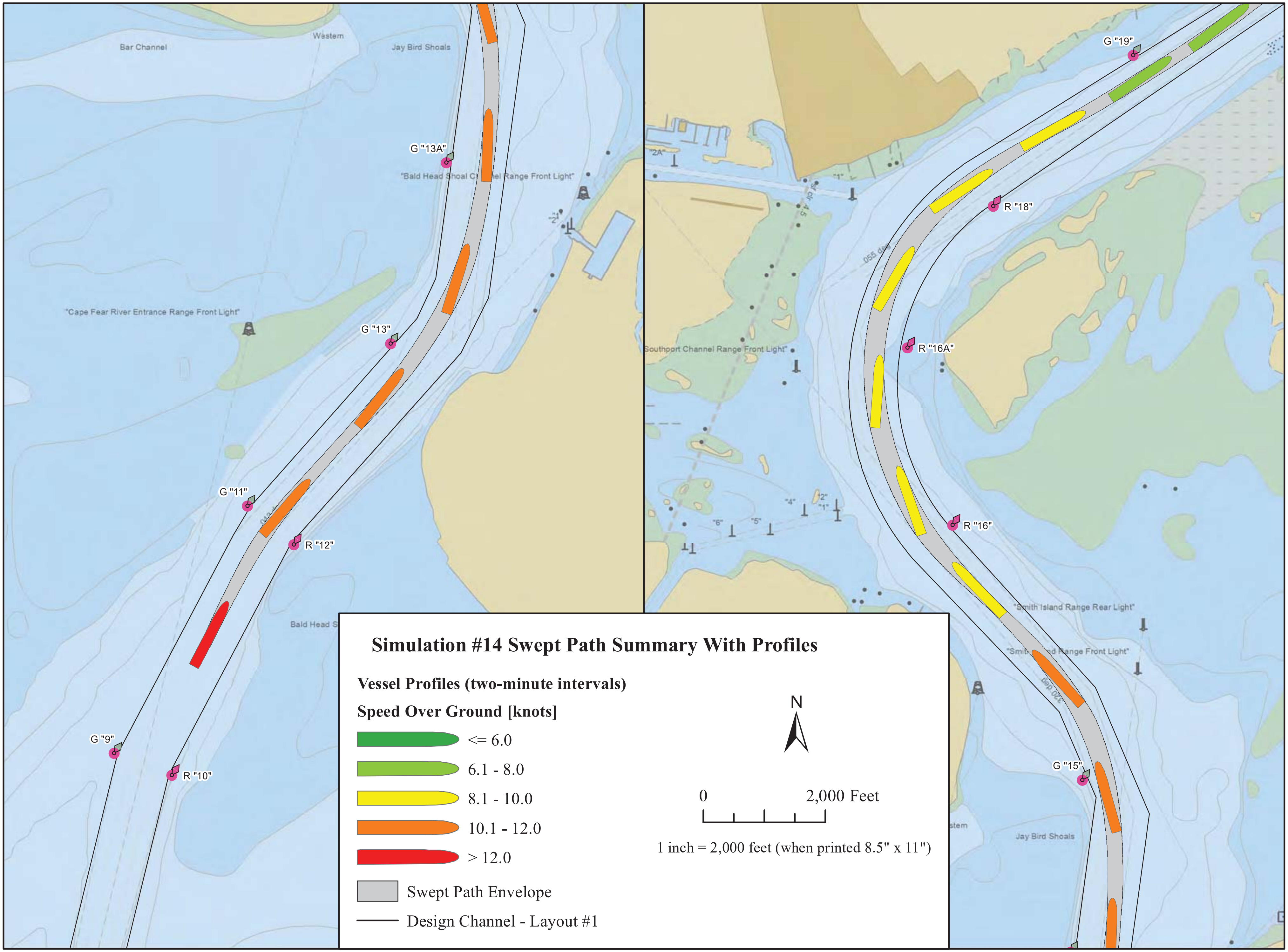
Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

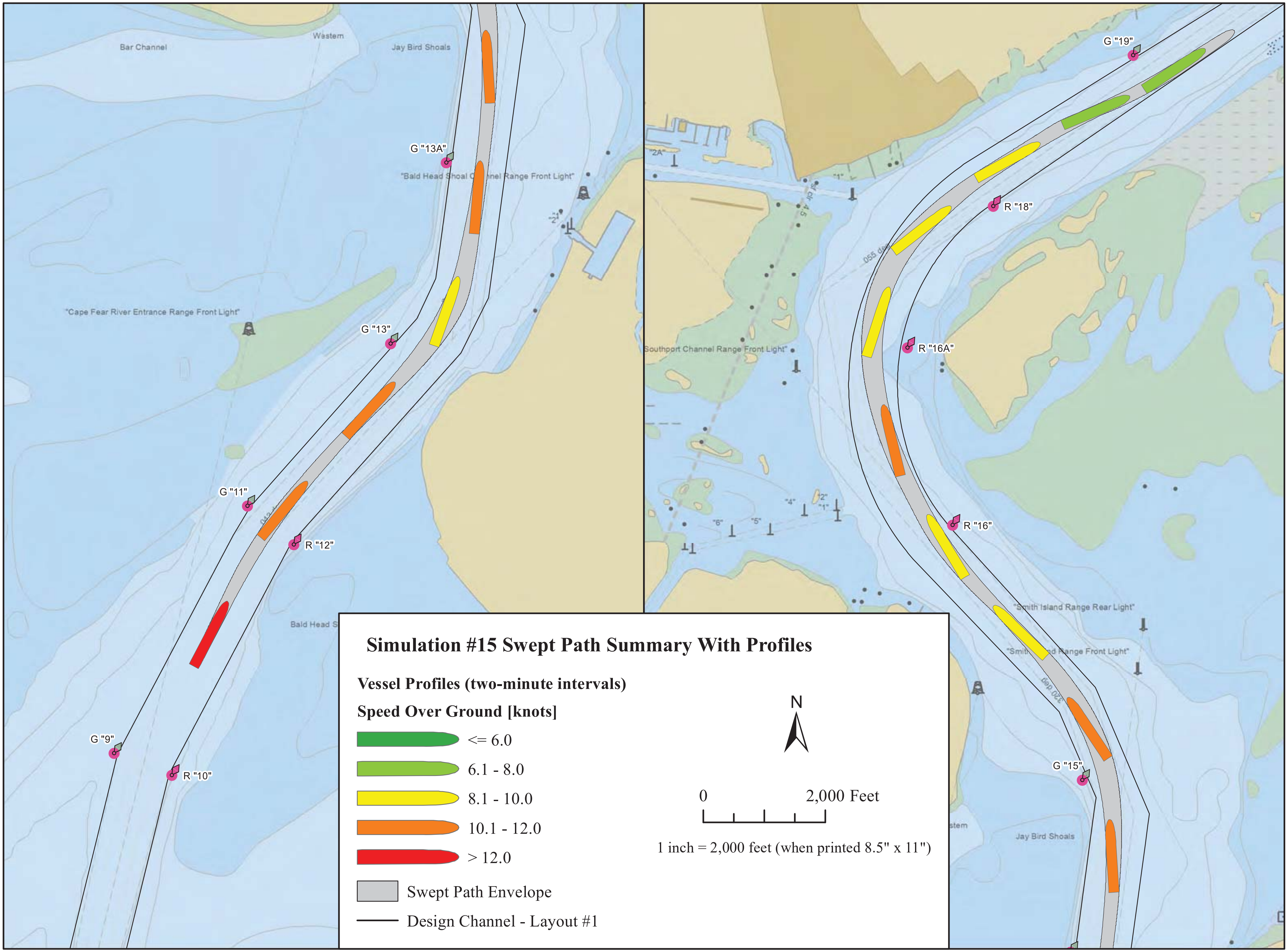
- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0
- ▨ Swept Path Envelope
- — Design Channel - Layout #2



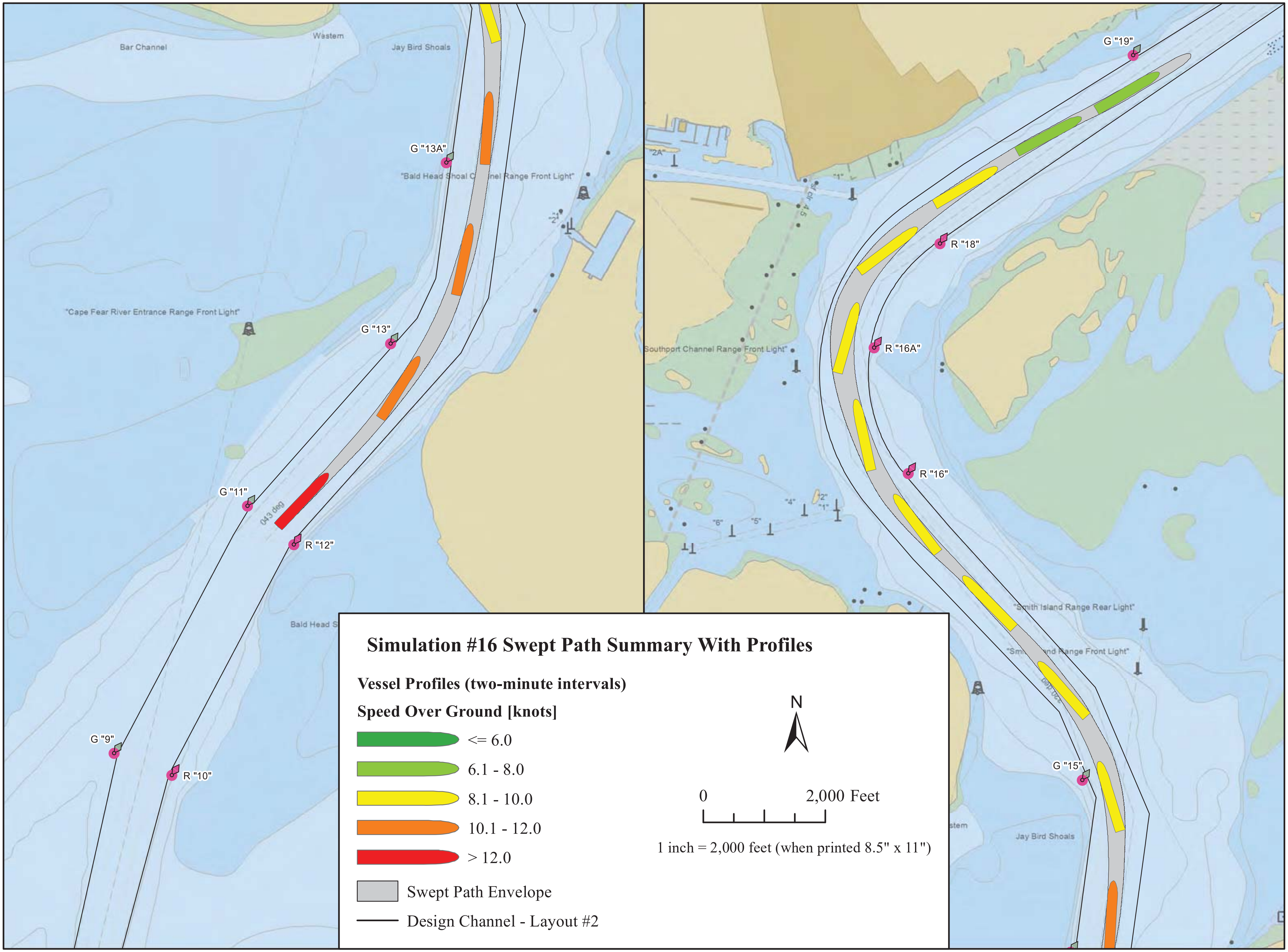
Simulation #13 Swept Path Summary With Profiles



Simulation #14 Swept Path Summary With Profiles



Simulation #15 Swept Path Summary With Profiles



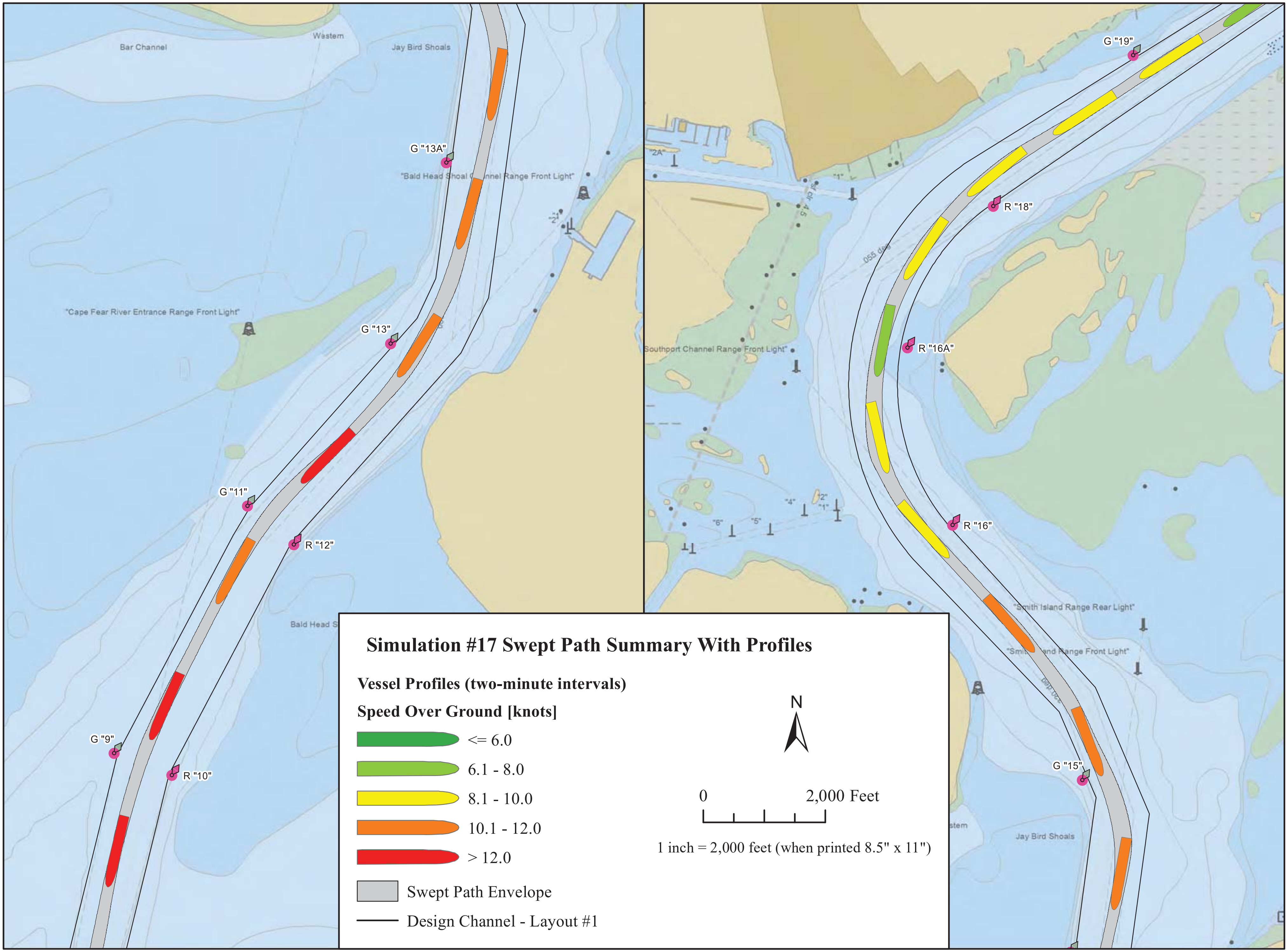
Simulation #16 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

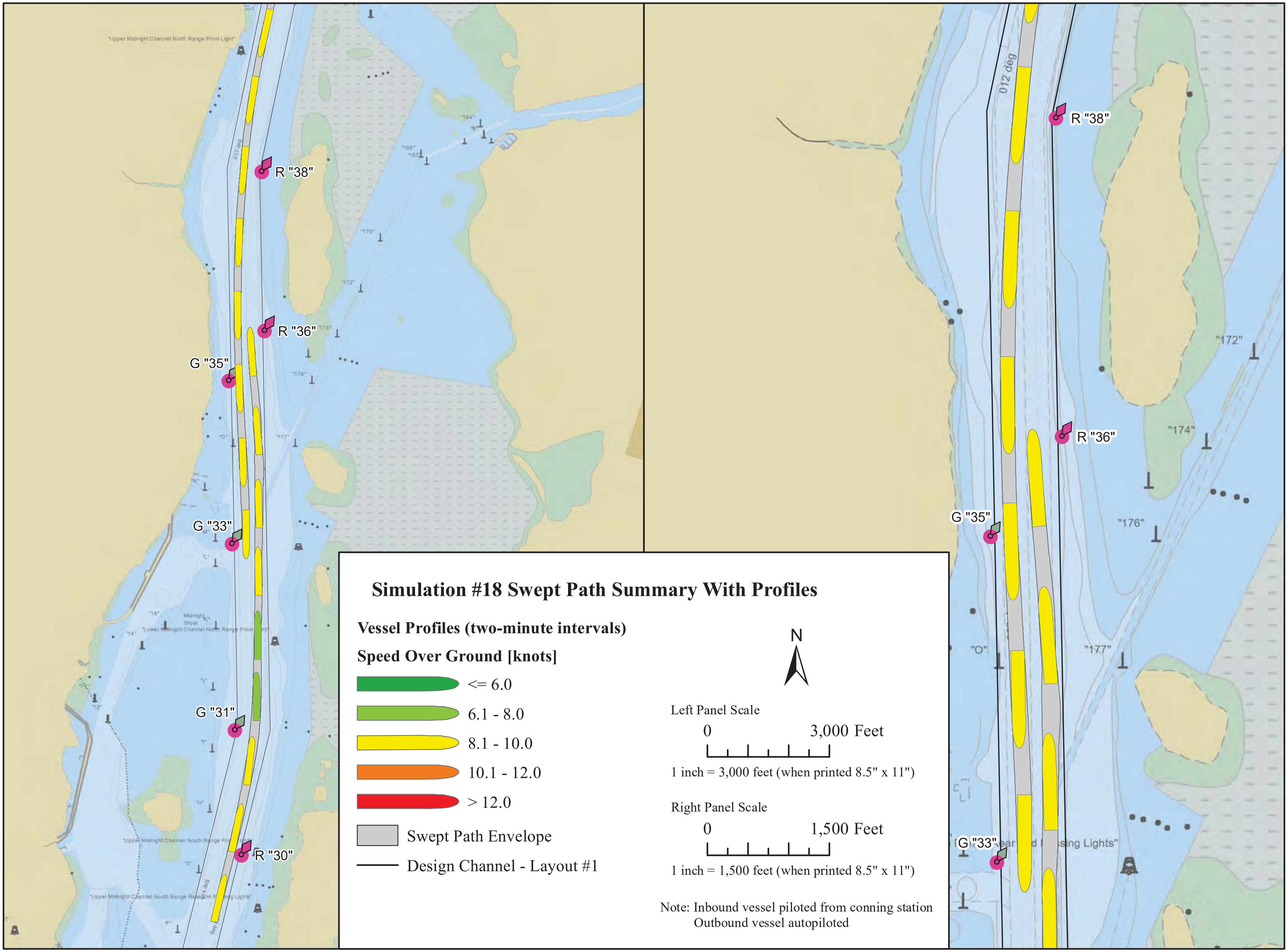
- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0
- ▨ Swept Path Envelope
- — Design Channel - Layout #2

1 inch = 2,000 feet (when printed 8.5" x 11")

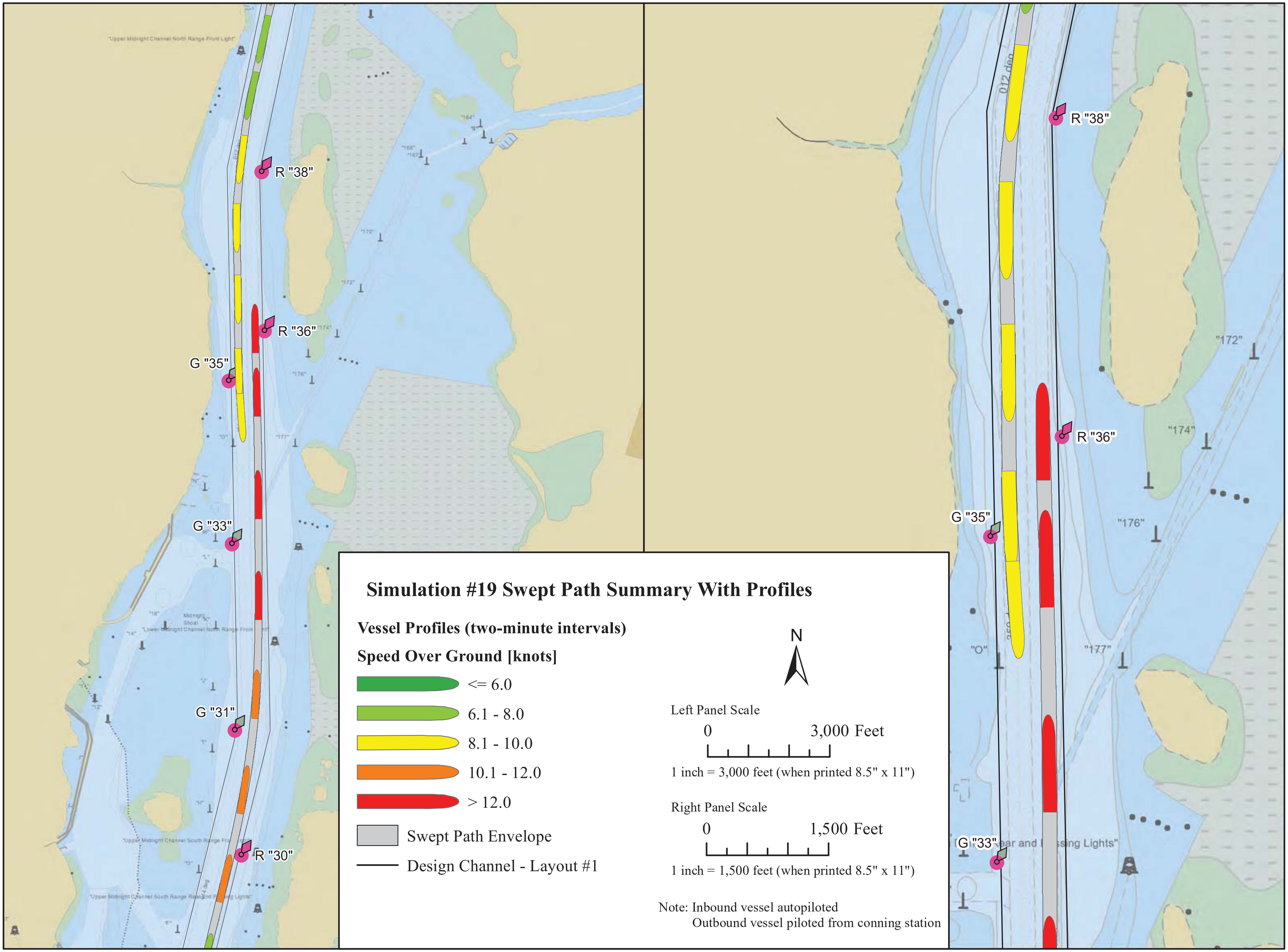


Simulation #17 Swept Path Summary With Profiles

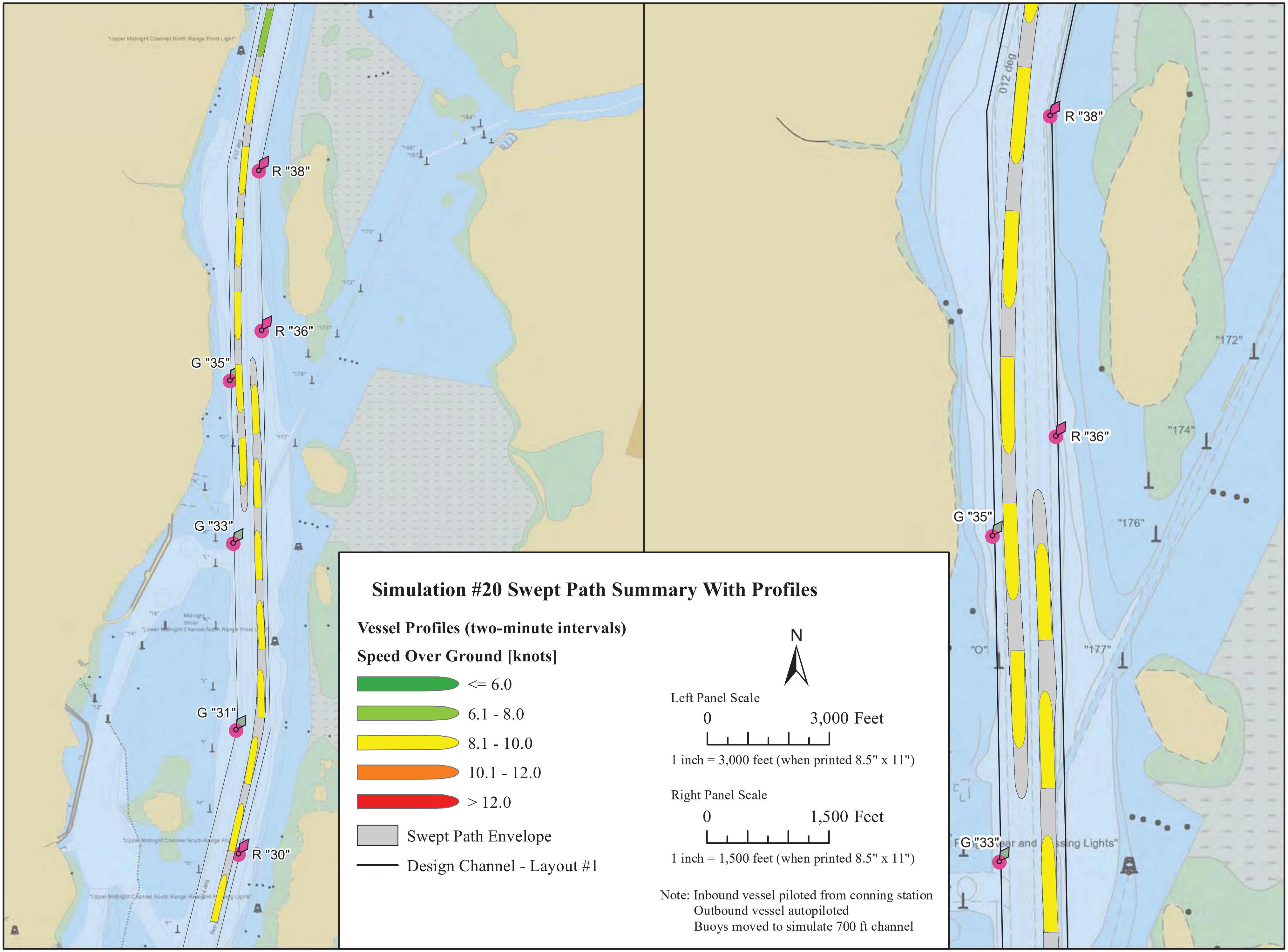
Simulation #18 Swept Path Summary With Profiles



Note: Inbound vessel piloted from conning station
Outbound vessel autopiloted



Simulation #19 Swept Path Summary With Profiles



Simulation #20 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

🟩	<= 6.0
🟩	6.1 - 8.0
🟨	8.1 - 10.0
🟧	10.1 - 12.0
🟥	> 12.0
▨	Swept Path Envelope
—	Design Channel - Layout #1

N

Left Panel Scale

0 3,000 Feet

1 inch = 3,000 feet (when printed 8.5" x 11")

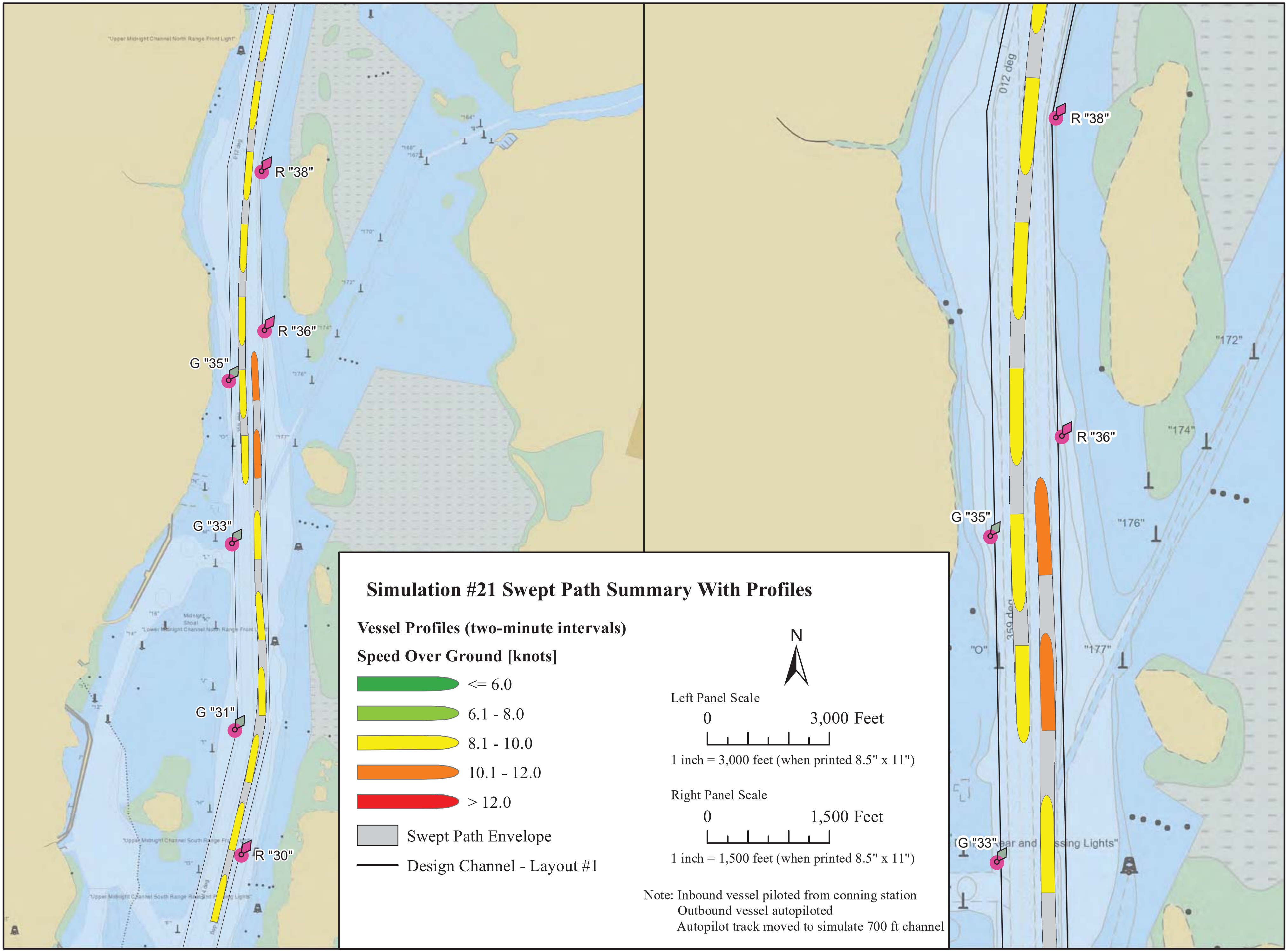
Right Panel Scale

0 1,500 Feet

1 inch = 1,500 feet (when printed 8.5" x 11")

Note: Inbound vessel piloted from conning station
Outbound vessel autopiloted
Buoys moved to simulate 700 ft channel

Simulation #21 Swept Path Summary With Profiles



Vessel Profiles (two-minute intervals)

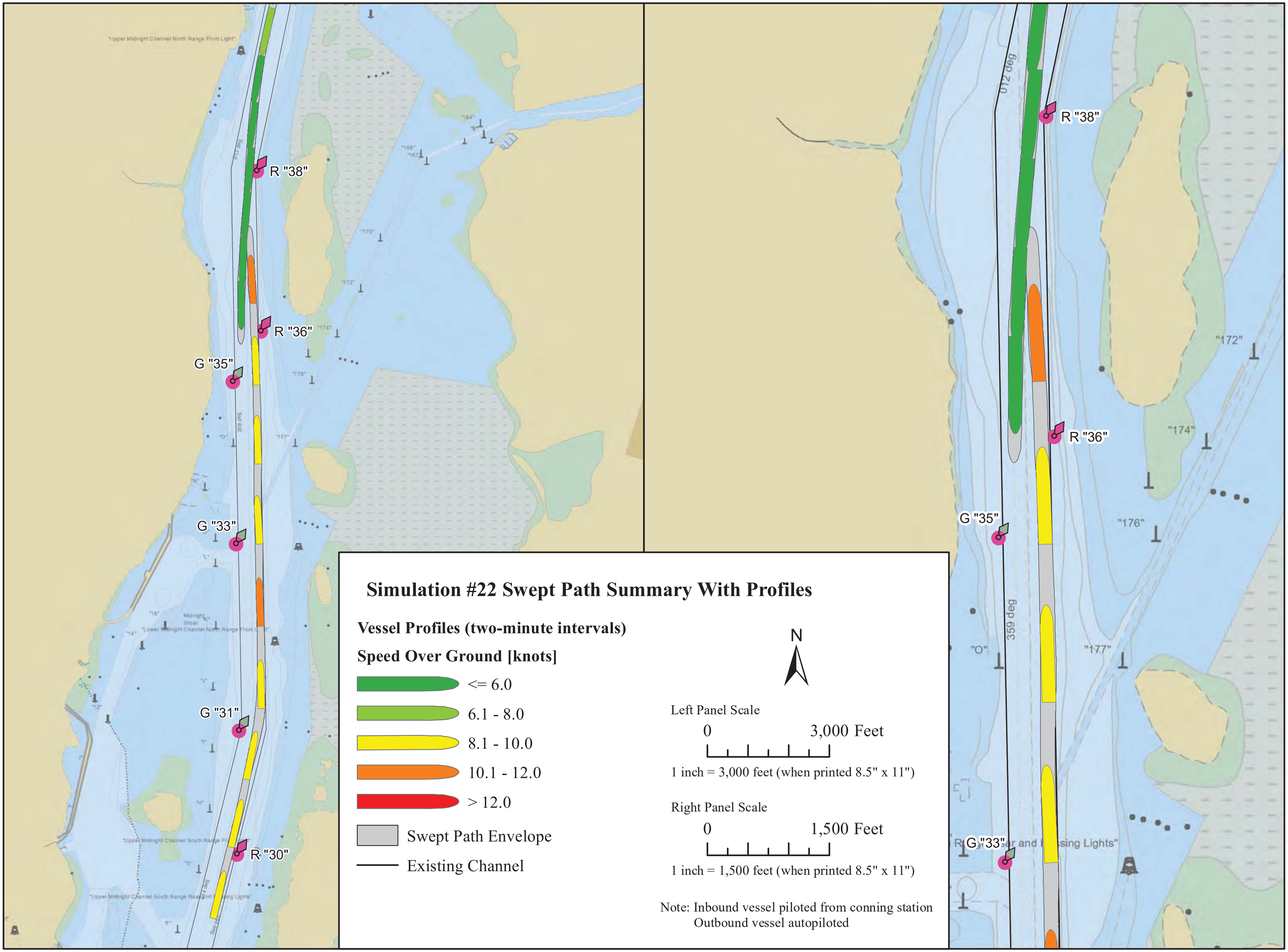
Speed Over Ground [knots]

- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0
- ▨ Swept Path Envelope
- — Design Channel - Layout #1

1 inch = 3,000 feet (when printed 8.5" x 11")

1 inch = 1,500 feet (when printed 8.5" x 11")

Note: Inbound vessel piloted from conning station
Outbound vessel autopiloted
Autopilot track moved to simulate 700 ft channel



Simulation #22 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0
- ▨ Swept Path Envelope
- — Existing Channel

N

Left Panel Scale

0 3,000 Feet

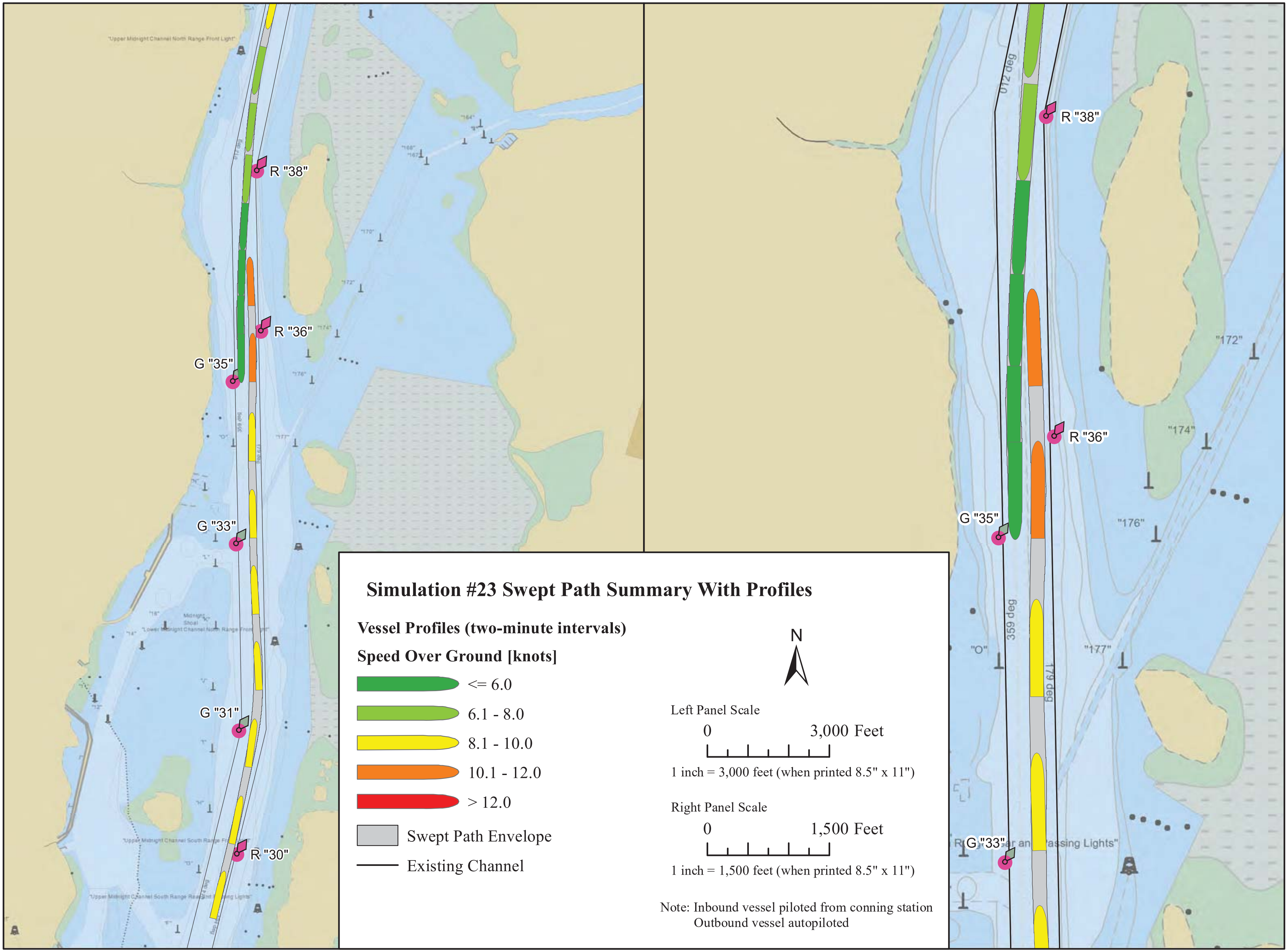
1 inch = 3,000 feet (when printed 8.5" x 11")

Right Panel Scale

0 1,500 Feet

1 inch = 1,500 feet (when printed 8.5" x 11")

Note: Inbound vessel piloted from conning station
Outbound vessel autopiloted



Simulation #23 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

🟩 <= 6.0

🟩 6.1 - 8.0

🟨 8.1 - 10.0

🟧 10.1 - 12.0

🟥 > 12.0

▨ Swept Path Envelope

— Existing Channel

Left Panel Scale

0 3,000 Feet

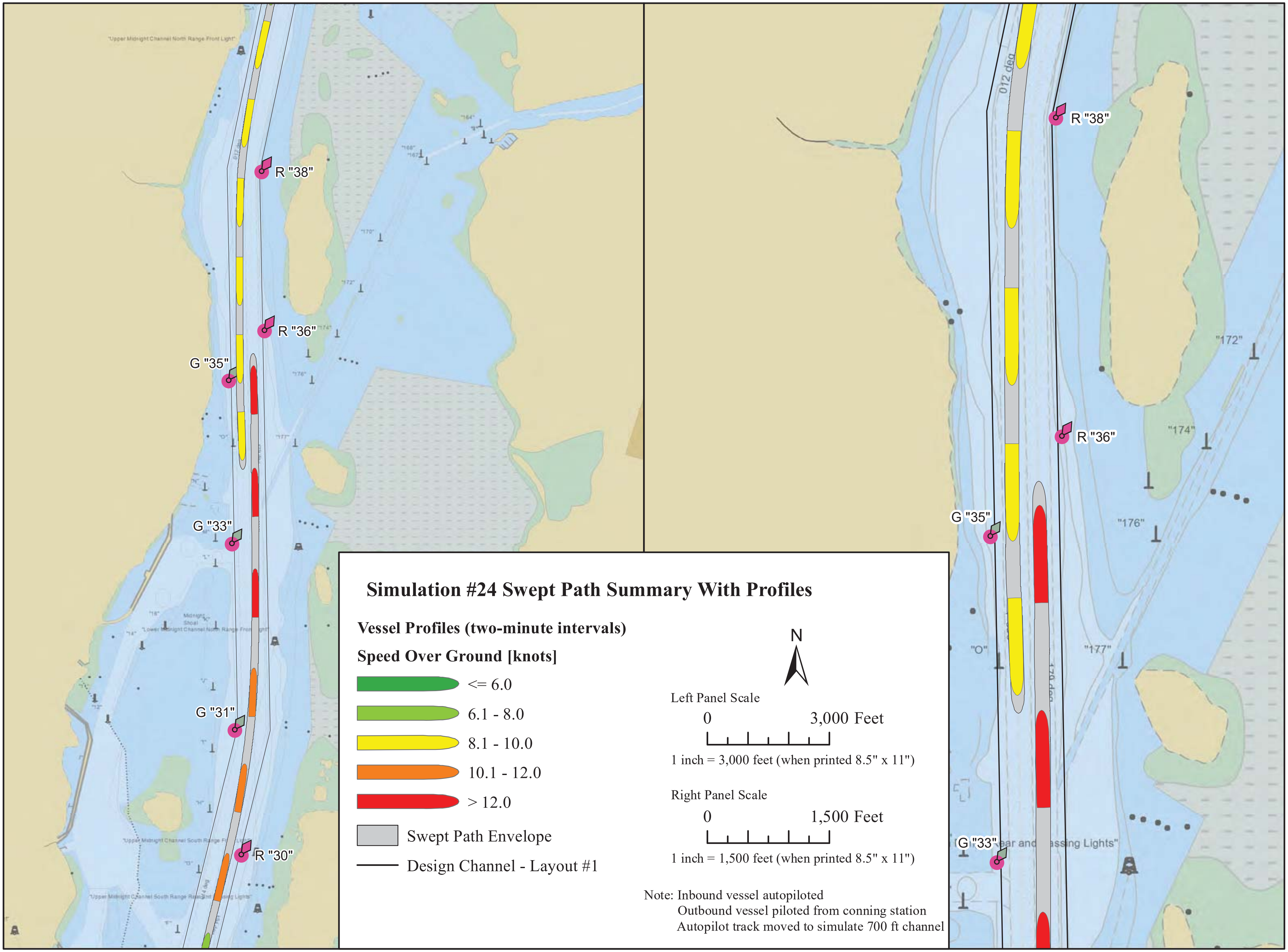
1 inch = 3,000 feet (when printed 8.5" x 11")

Right Panel Scale

0 1,500 Feet

1 inch = 1,500 feet (when printed 8.5" x 11")

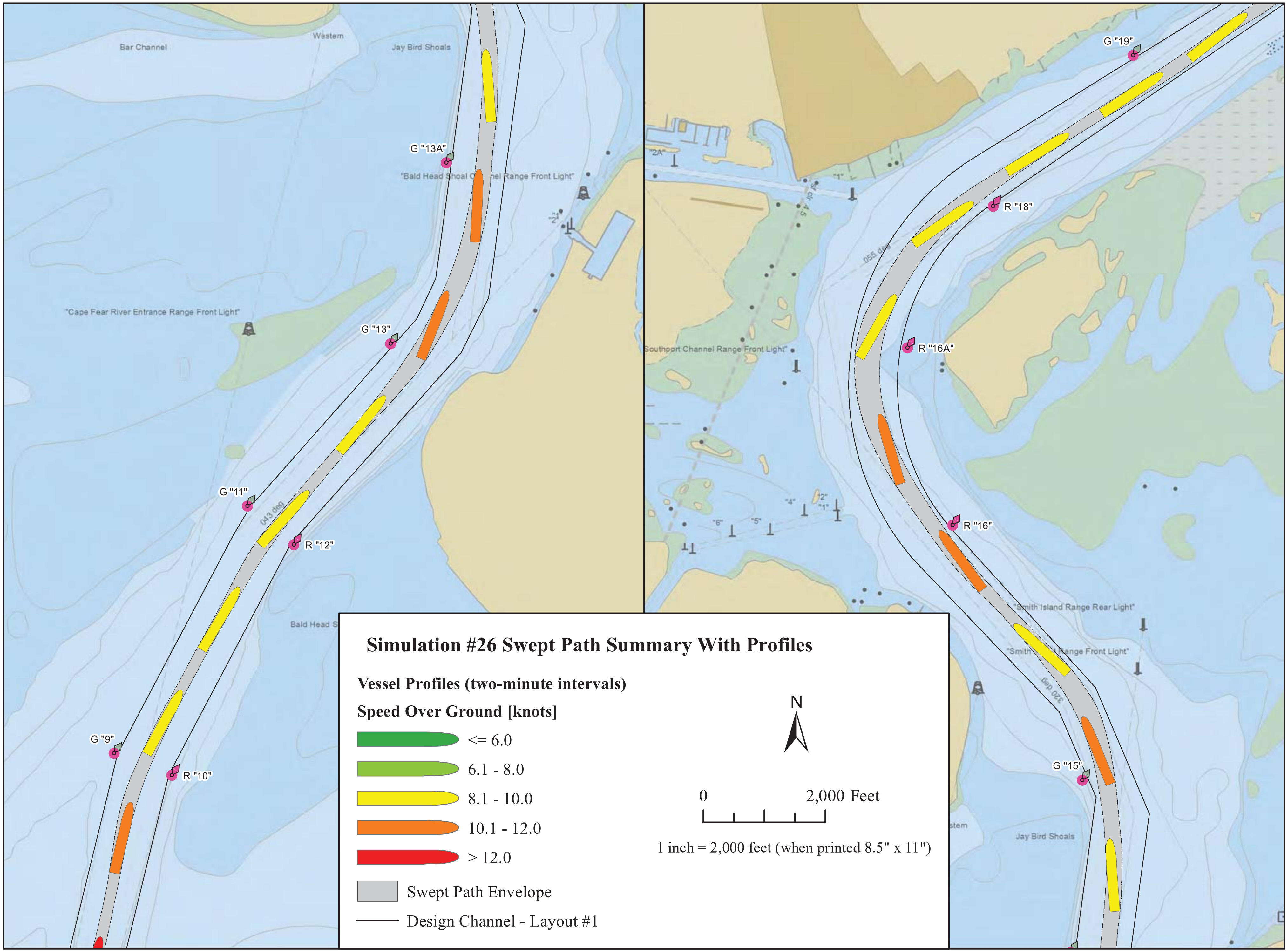
Note: Inbound vessel piloted from conning station
Outbound vessel autopiloted

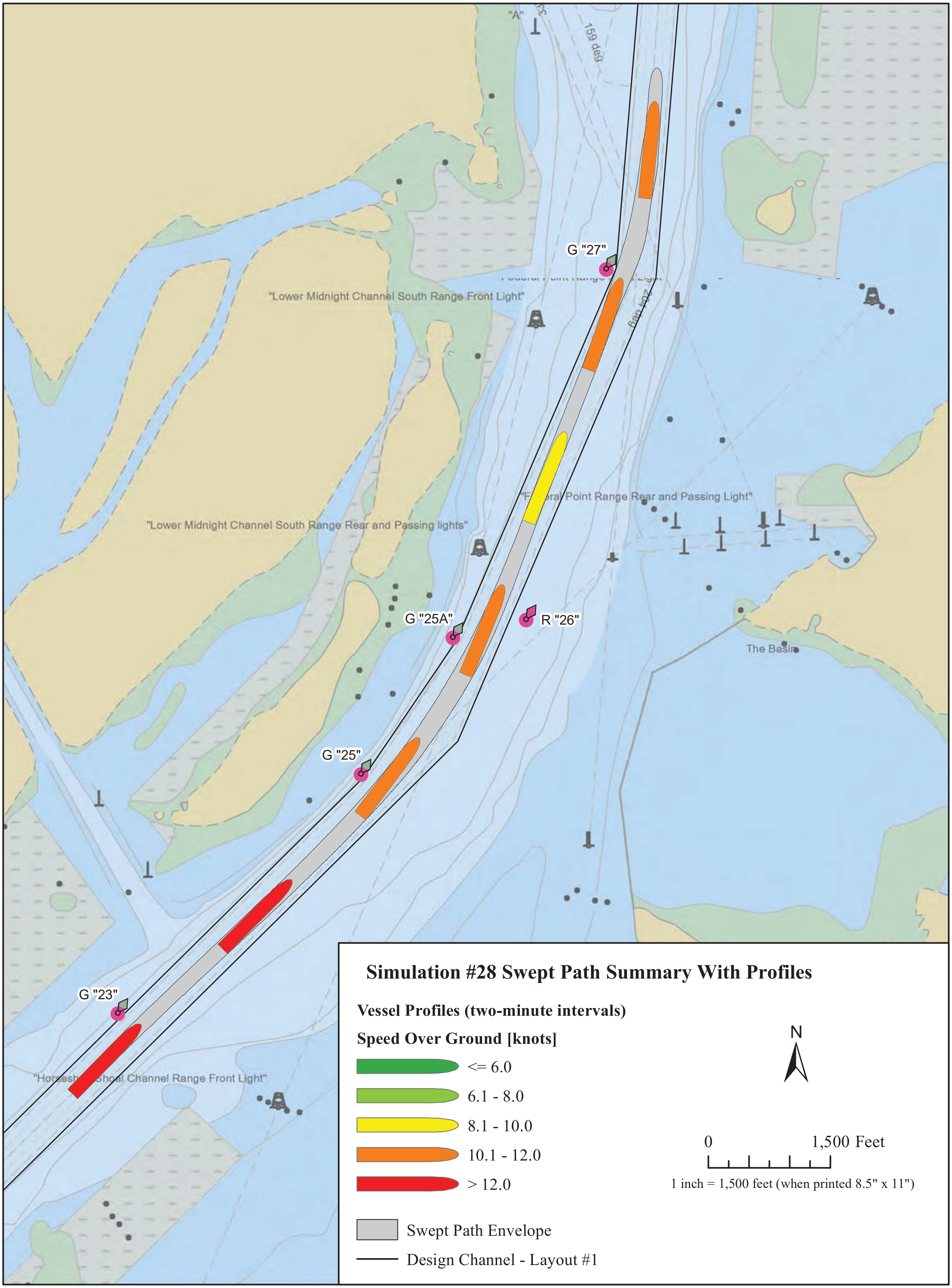


Simulation #24 Swept Path Summary With Profiles

Note: Inbound vessel autopiloted
Outbound vessel piloted from conning station
Autopilot track moved to simulate 700 ft channel

Simulation #26 Swept Path Summary With Profiles





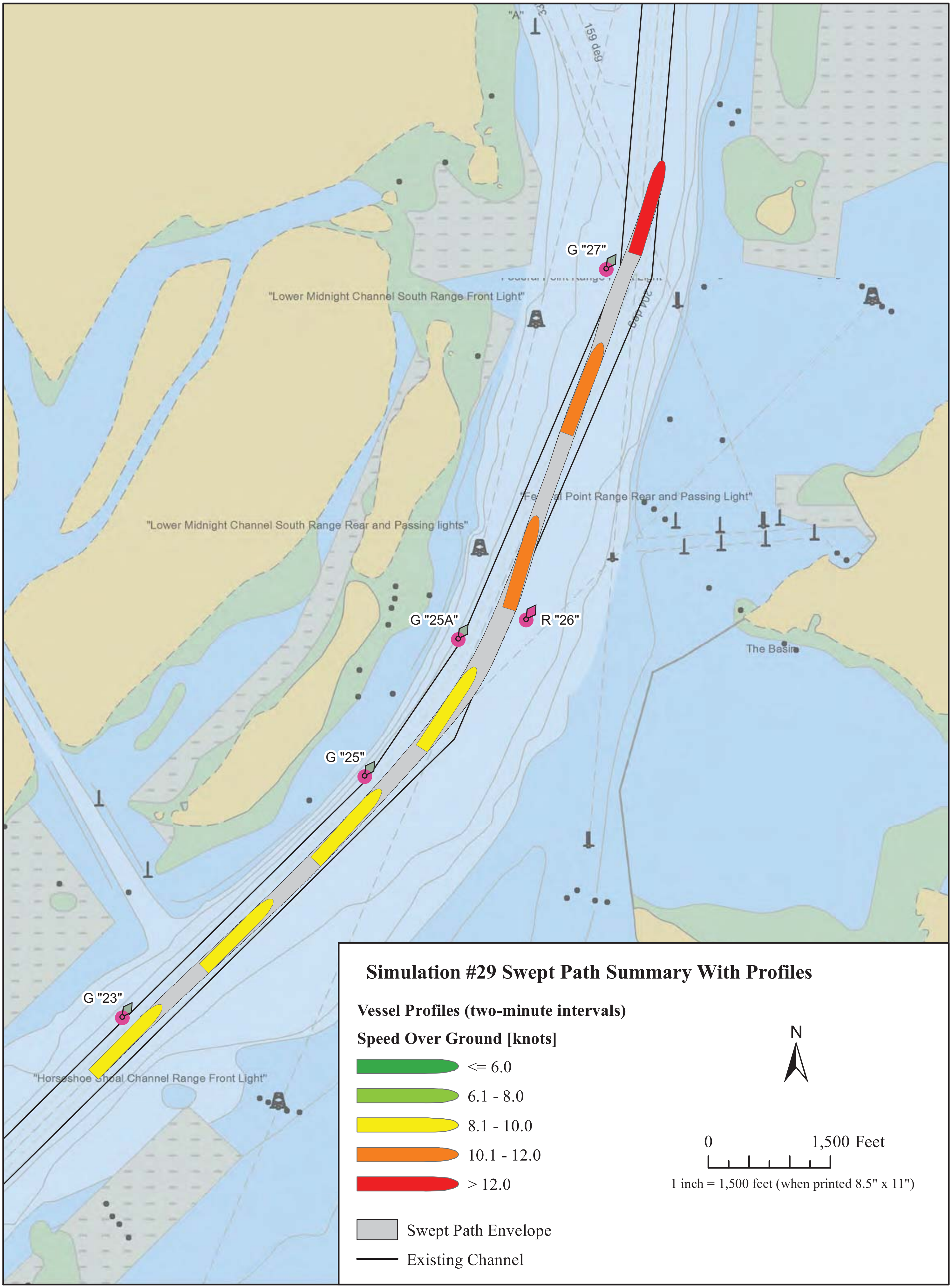
Simulation #28 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

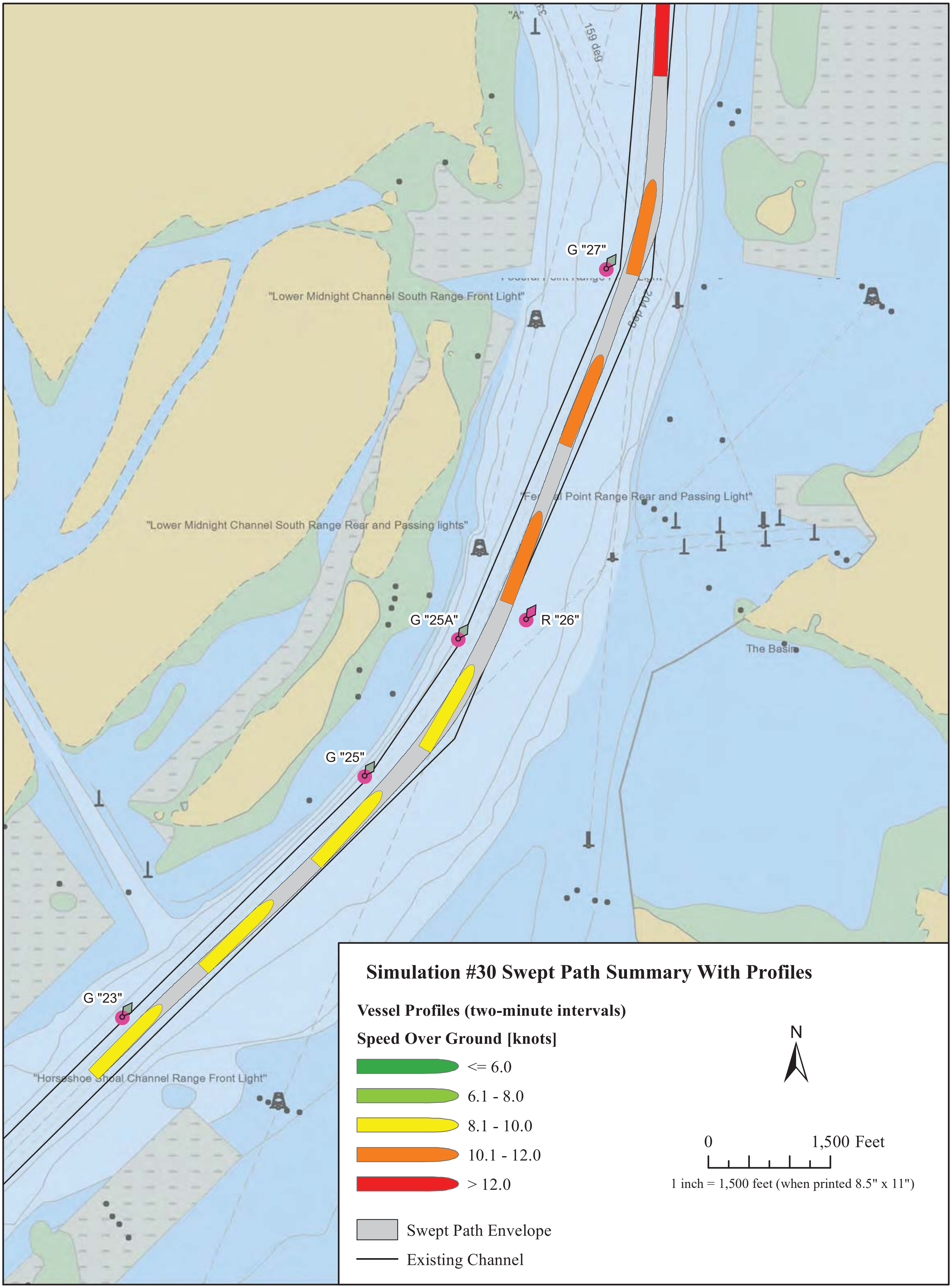
Speed Over Ground [knots]

🟩	<= 6.0
🟩	6.1 - 8.0
🟨	8.1 - 10.0
🟧	10.1 - 12.0
🟥	> 12.0
▨	Swept Path Envelope
—	Design Channel - Layout #1

1 inch = 1,500 feet (when printed 8.5" x 11")



Simulation #29 Swept Path Summary With Profiles



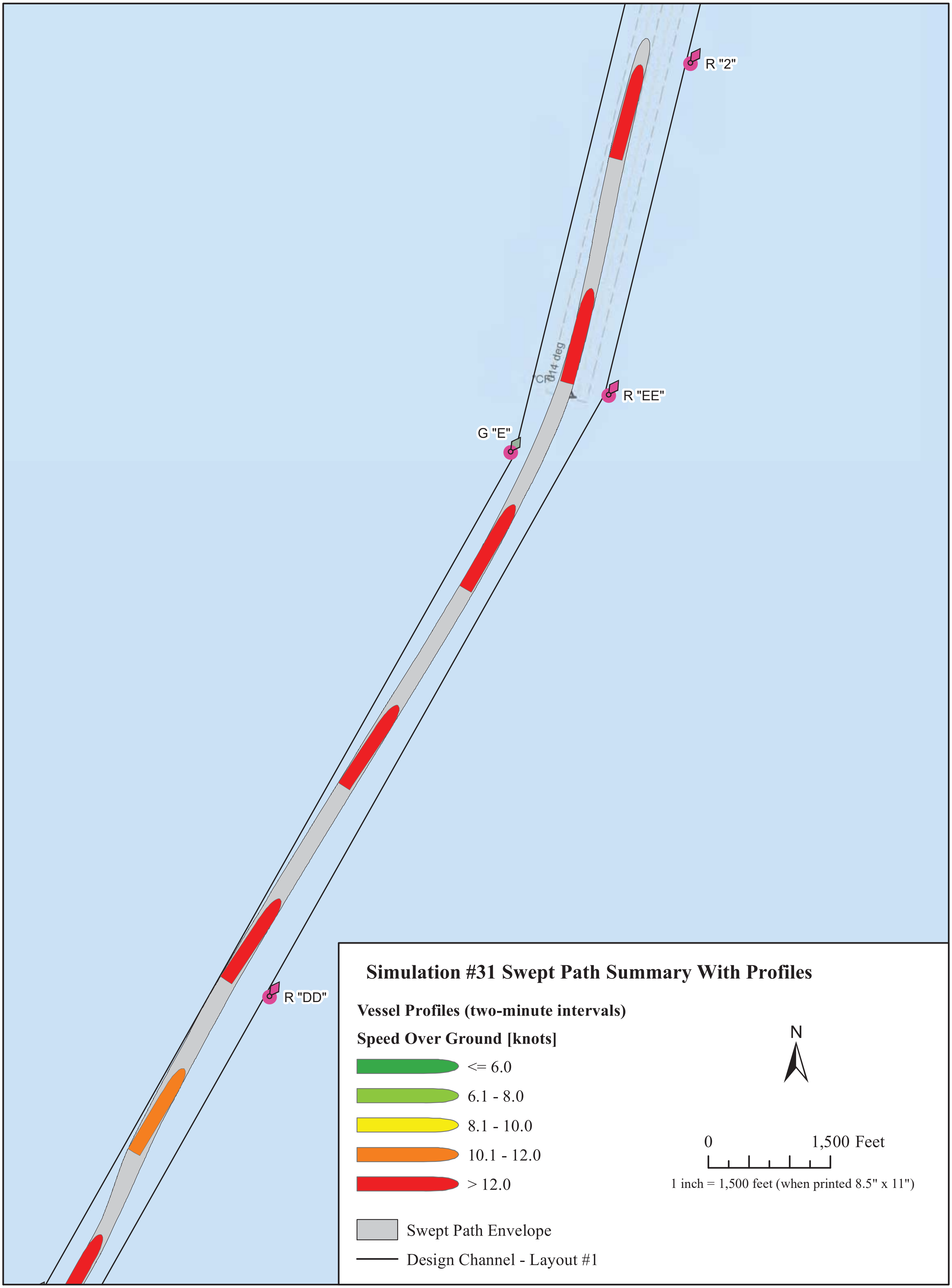
Simulation #30 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

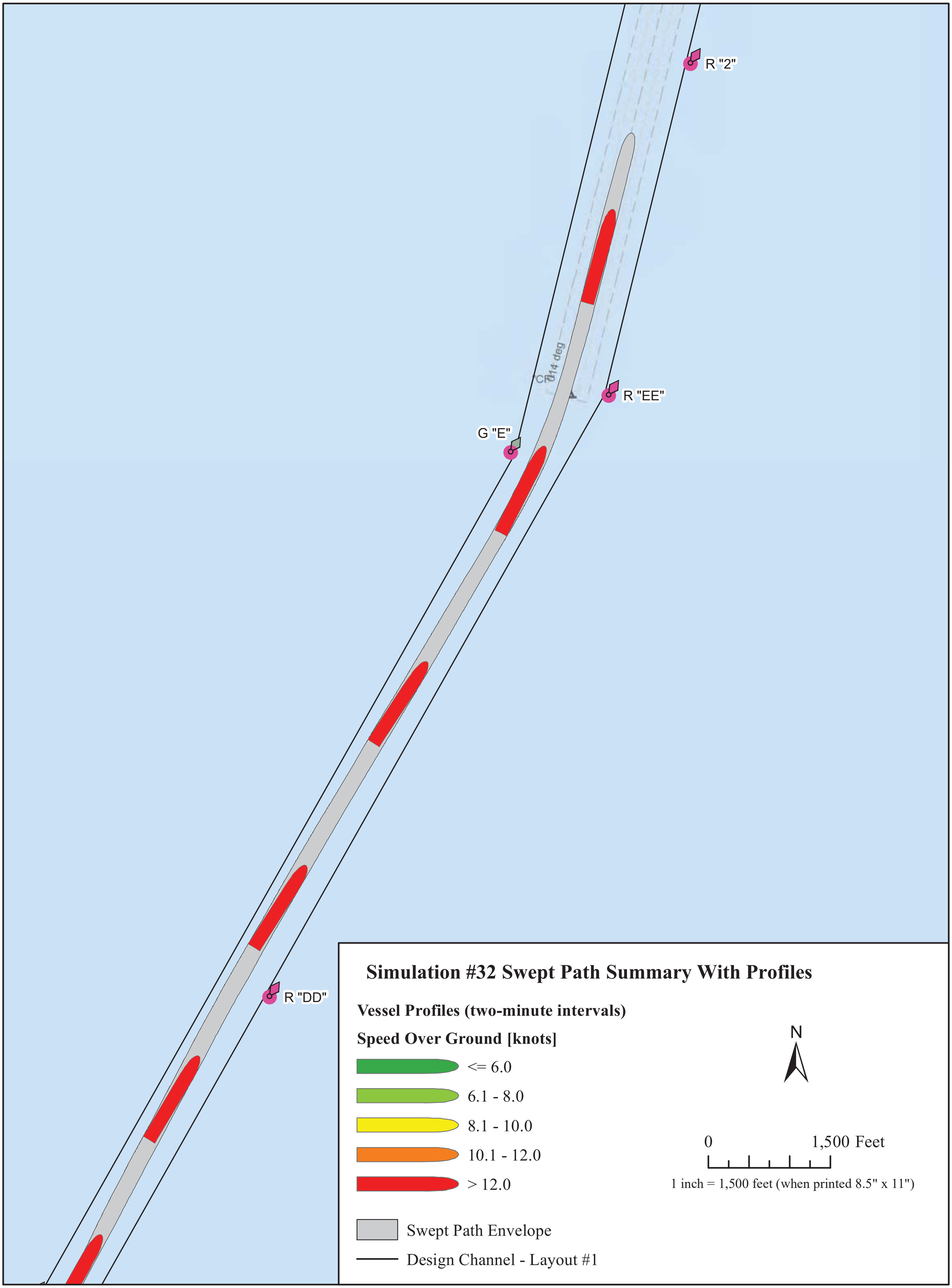
Speed Over Ground [knots]

- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0

- ▨ Swept Path Envelope
- — Existing Channel



Simulation #31 Swept Path Summary With Profiles



Simulation #32 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

🟩 <= 6.0

🟩 6.1 - 8.0

🟨 8.1 - 10.0

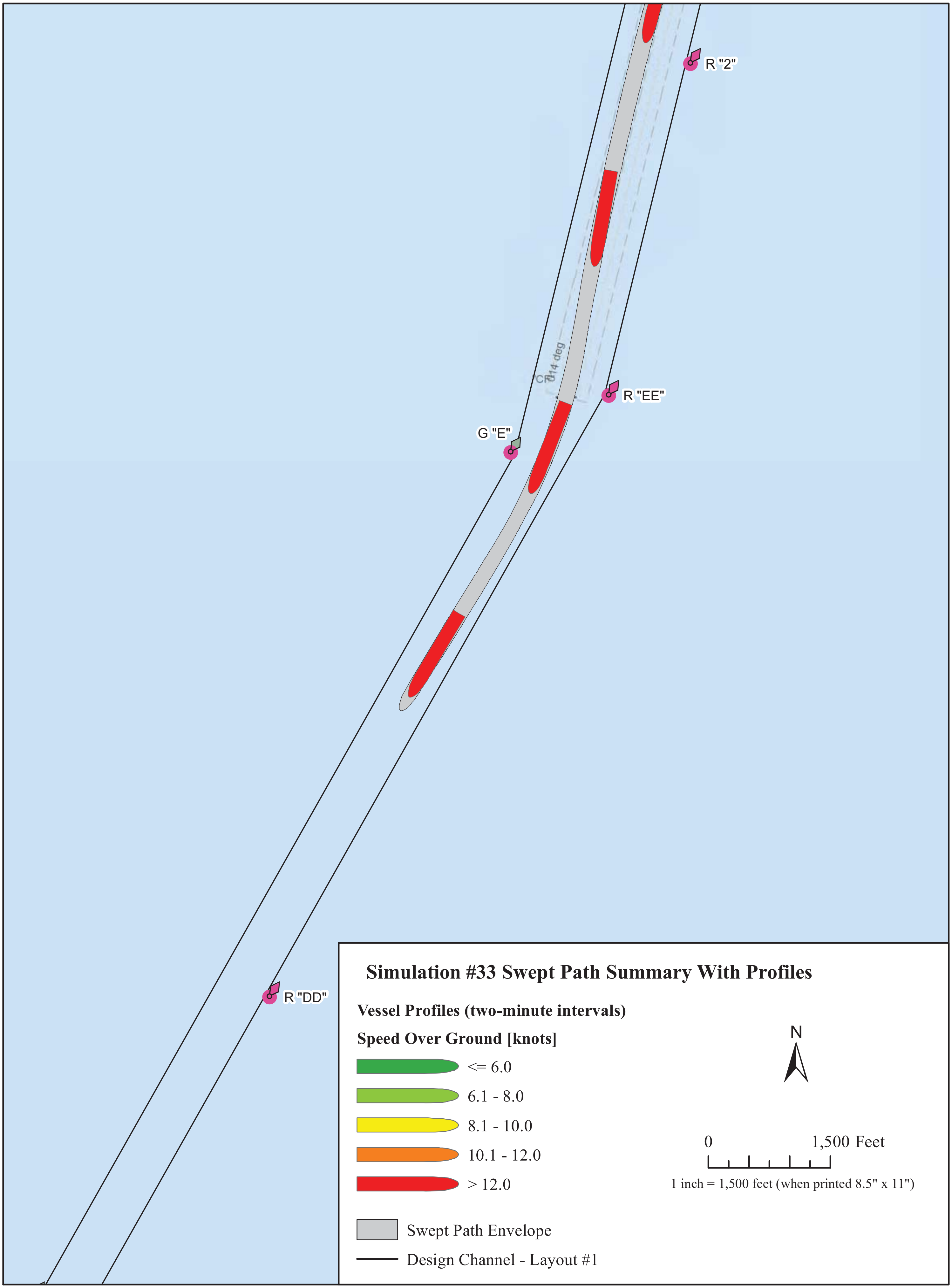
🟧 10.1 - 12.0

🟥 > 12.0

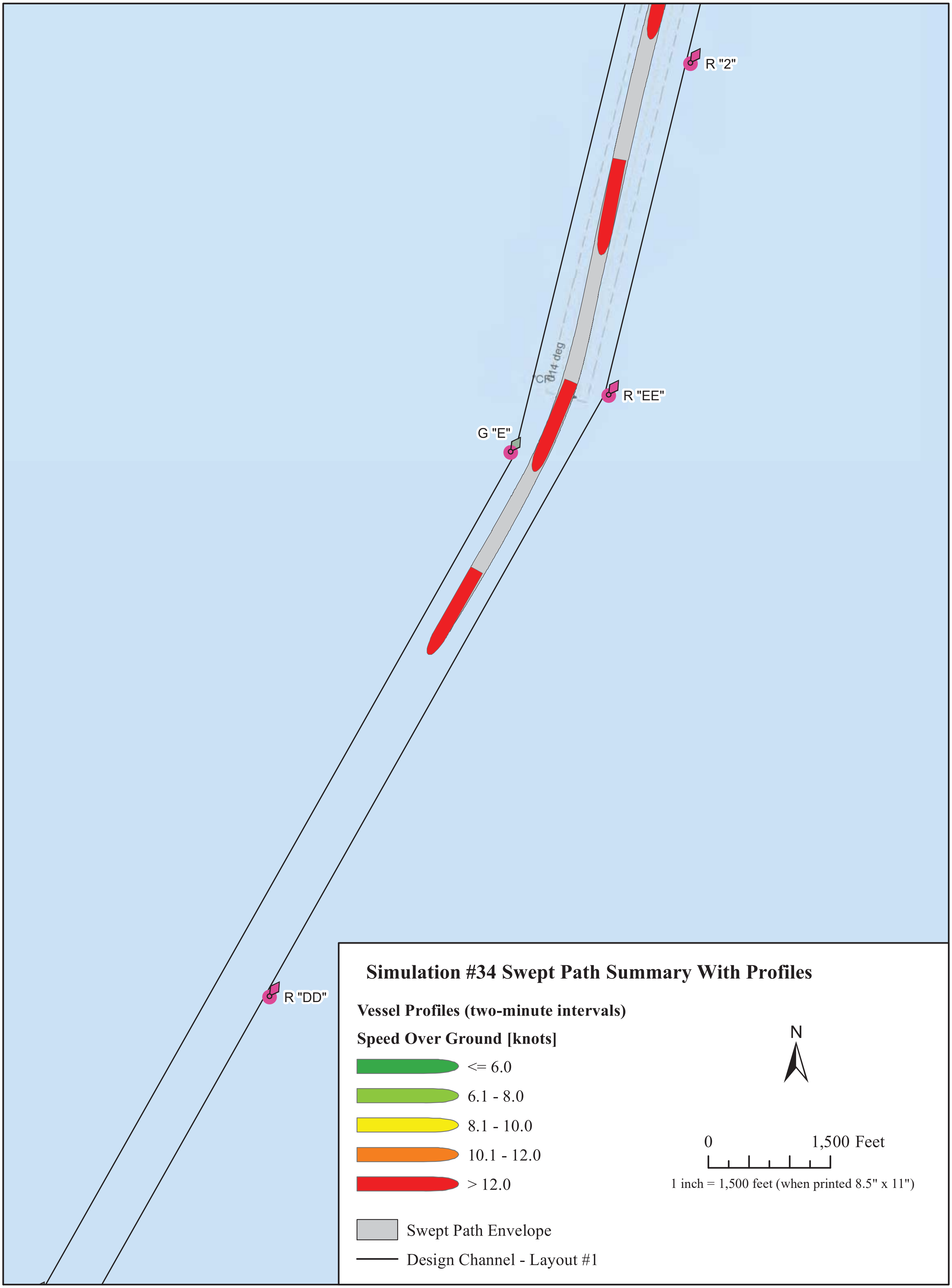
1 inch = 1,500 feet (when printed 8.5" x 11")

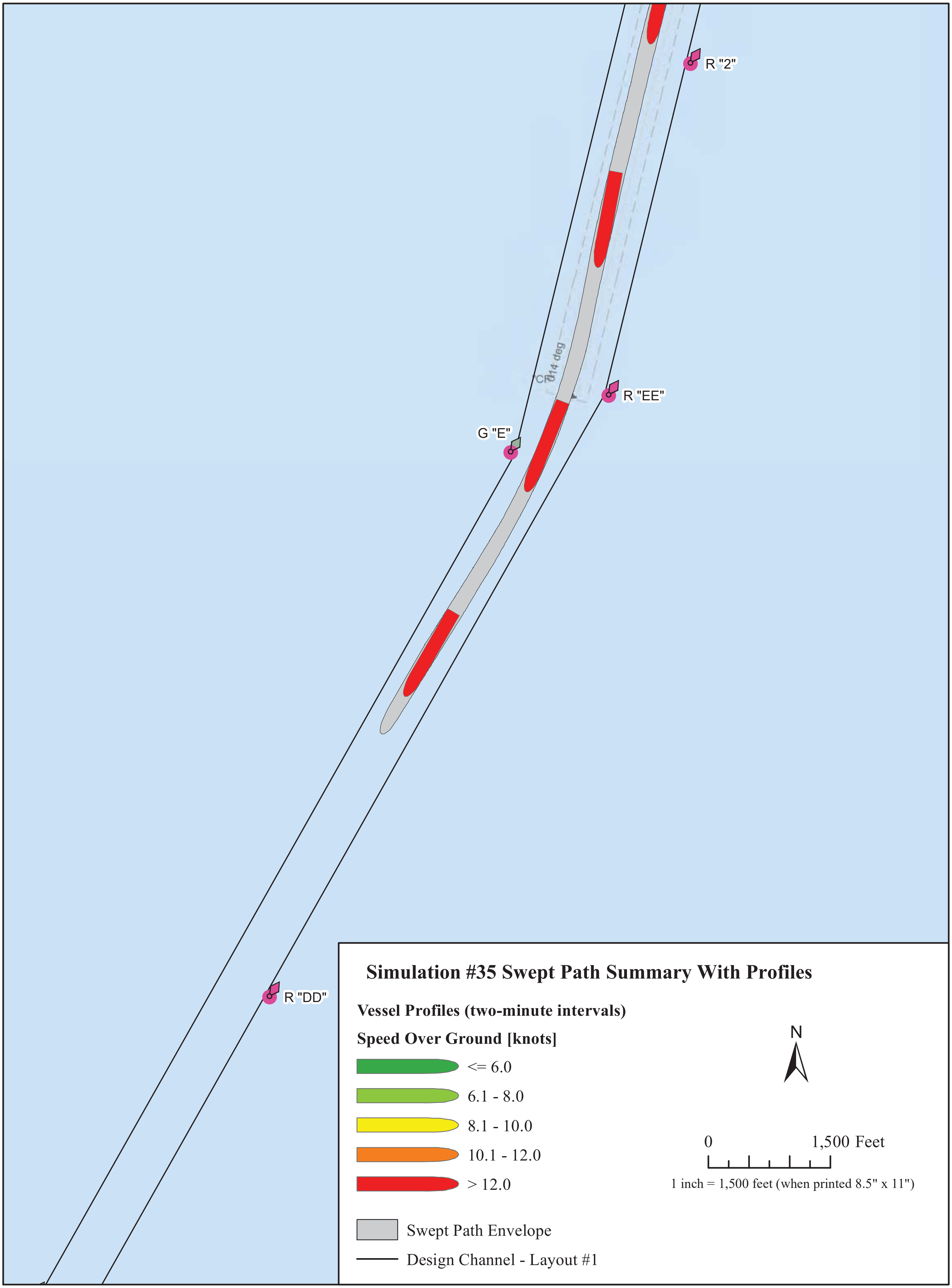
▨ Swept Path Envelope

— Design Channel - Layout #1



Simulation #33 Swept Path Summary With Profiles

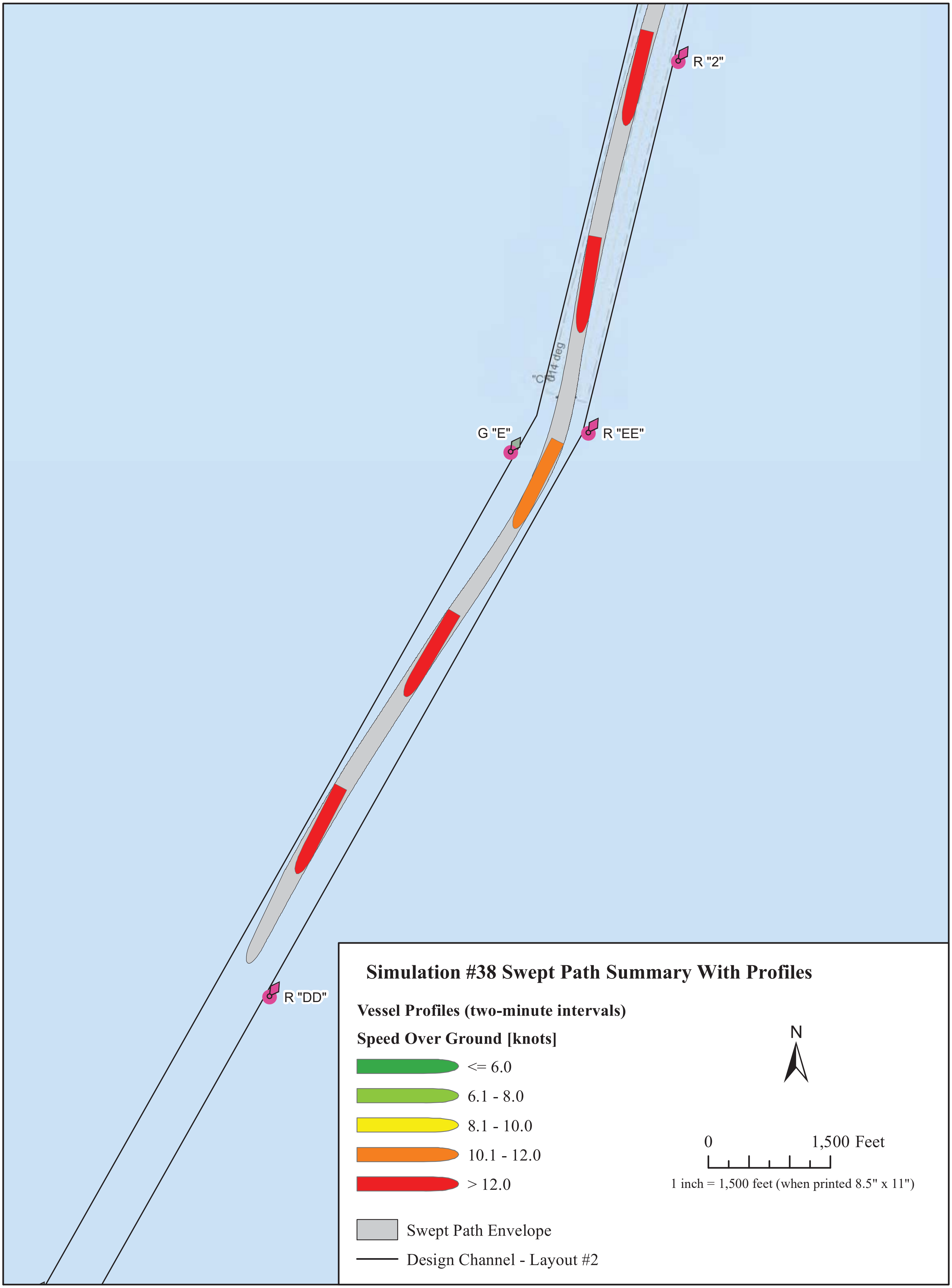

Simulation #34 Swept Path Summary With Profiles



Simulation #35 Swept Path Summary With Profiles

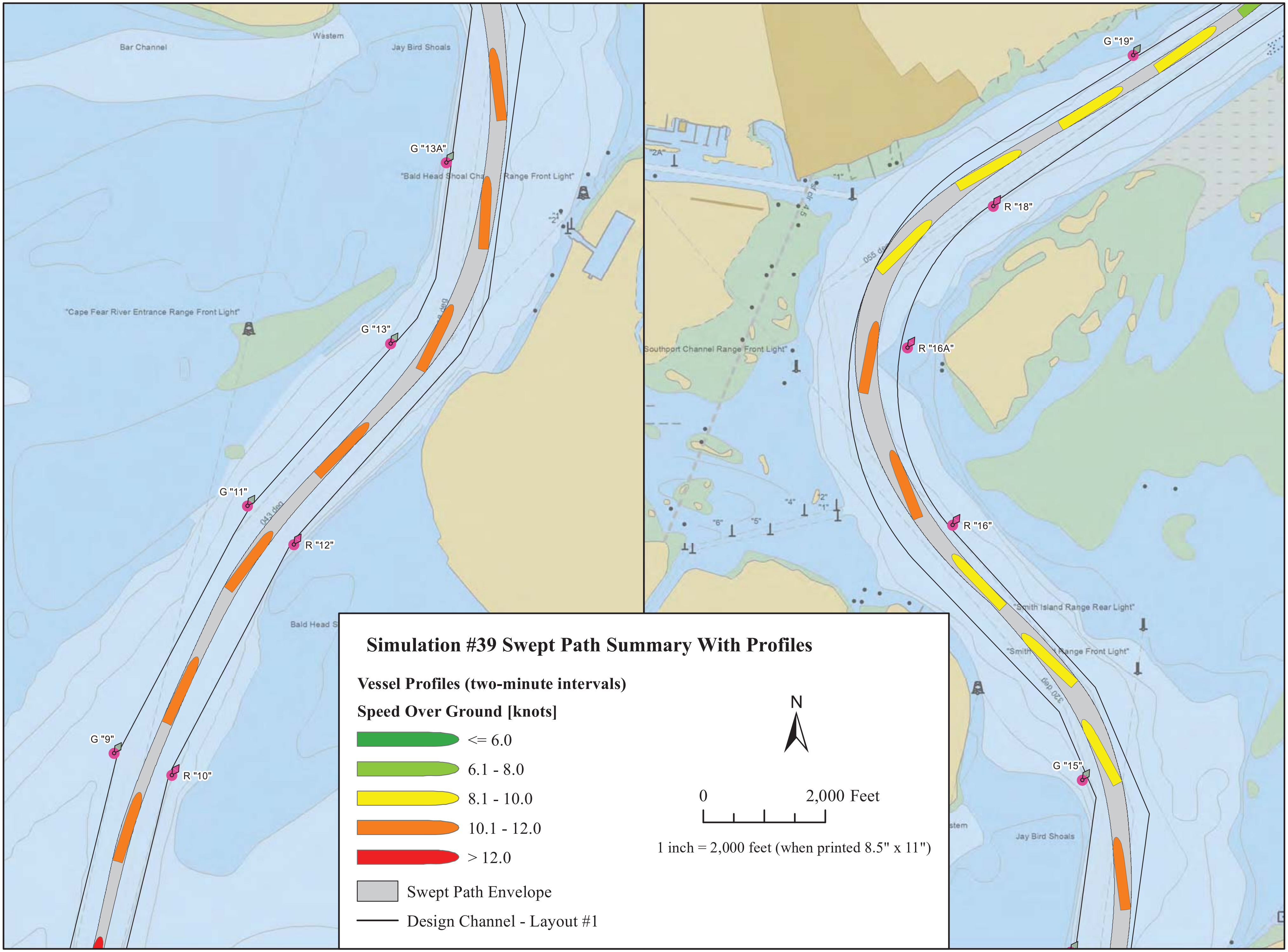
Simulation #36 Swept Path Summary With Profiles

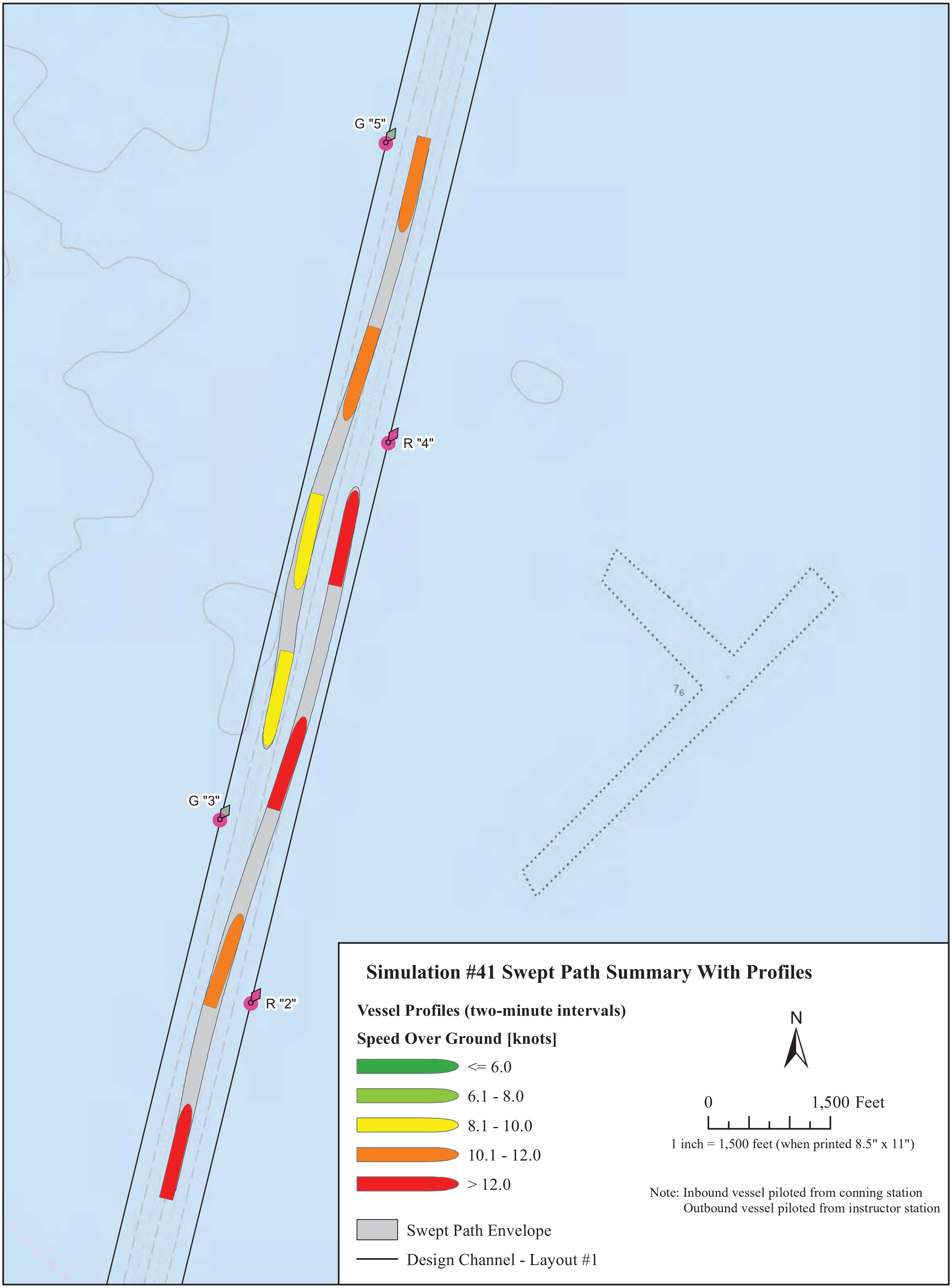
Simulation #37 Swept Path Summary With Profiles



Simulation #38 Swept Path Summary With Profiles

Simulation #39 Swept Path Summary With Profiles





Simulation #41 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

🟩 <= 6.0

🟩 6.1 - 8.0

🟨 8.1 - 10.0

🟧 10.1 - 12.0

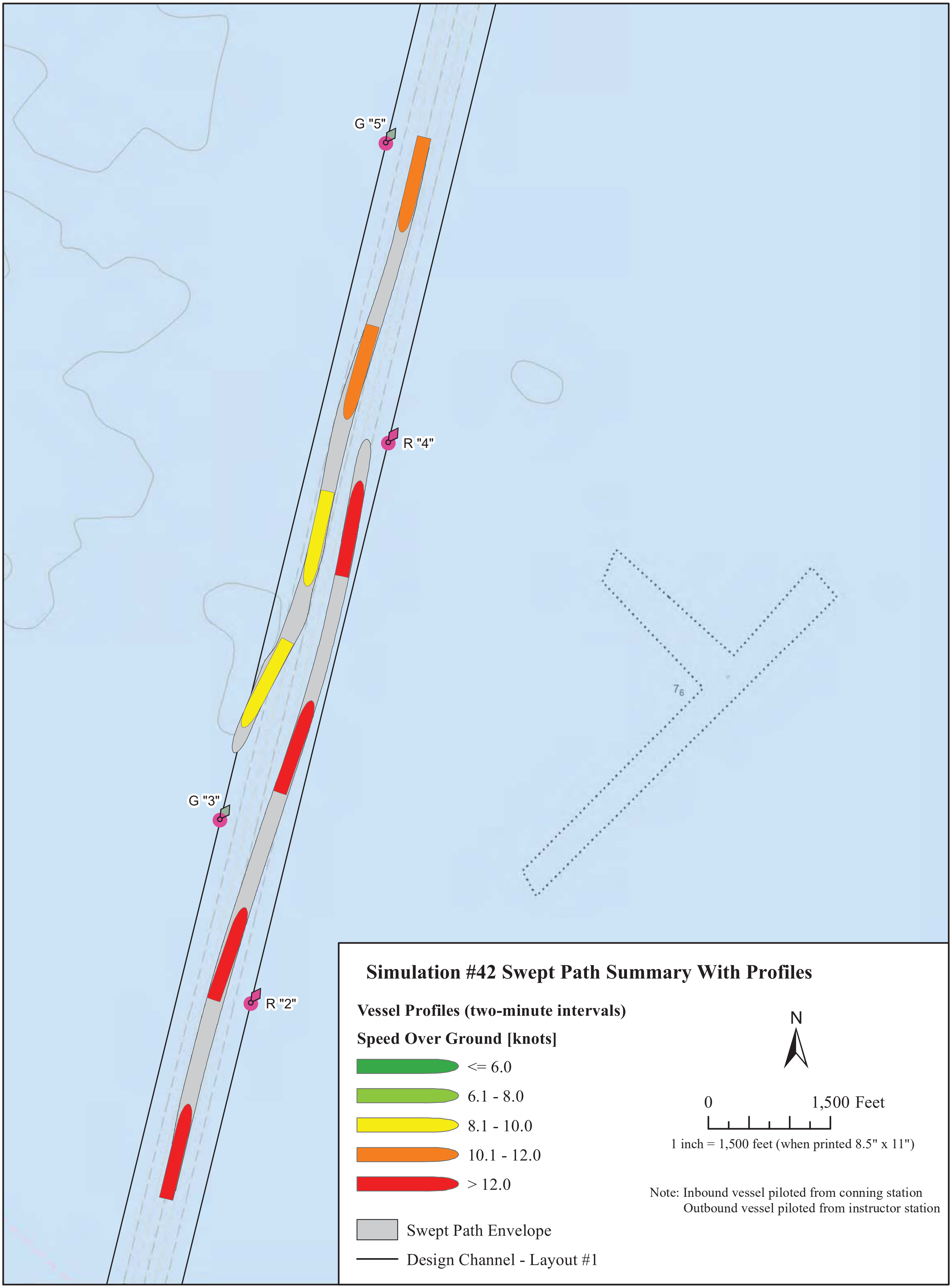
🟥 > 12.0

▨ Swept Path Envelope

— Design Channel - Layout #1

1 inch = 1,500 feet (when printed 8.5" x 11")

Note: Inbound vessel piloted from conning station
Outbound vessel piloted from instructor station

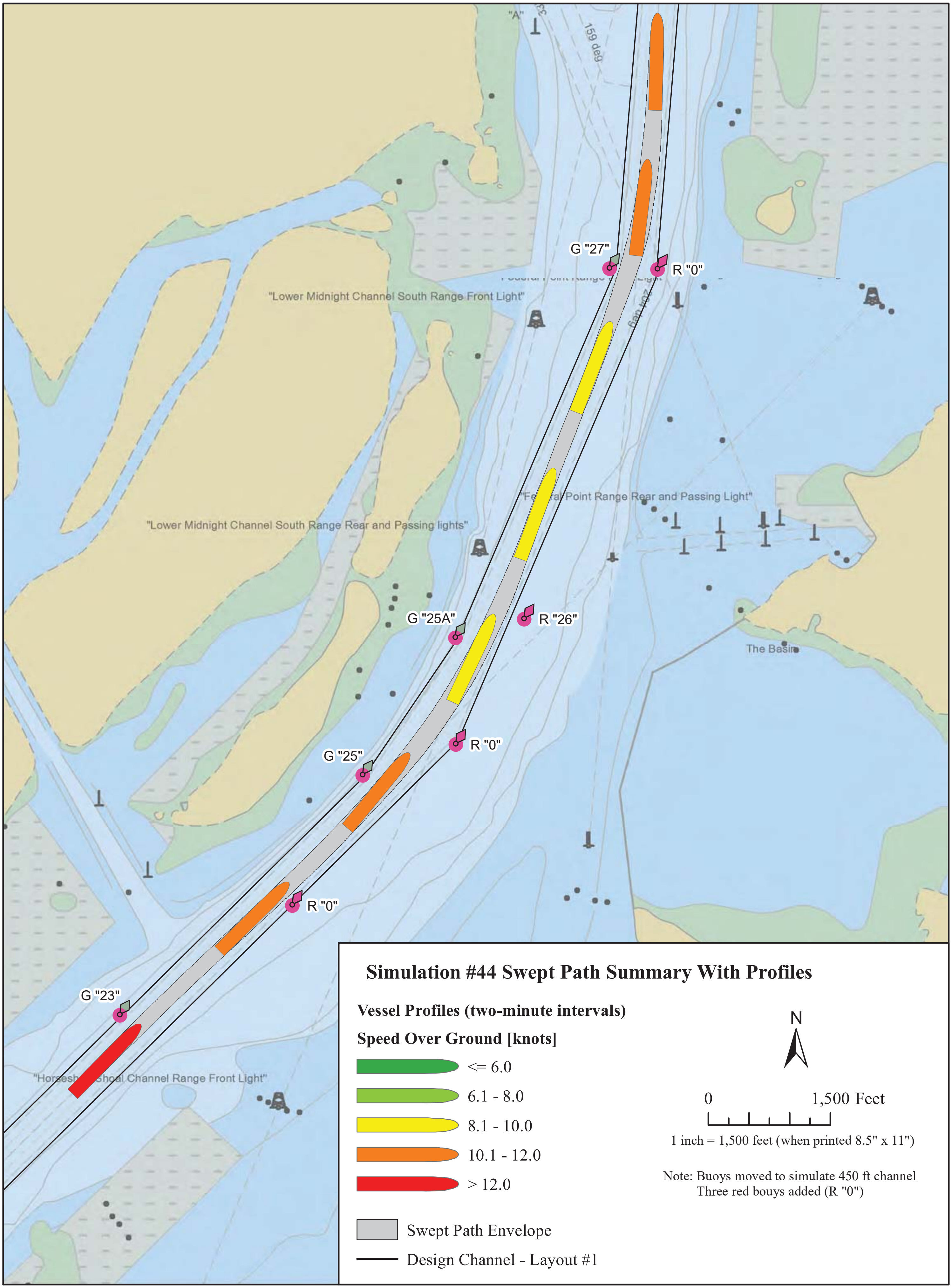


Simulation #42 Swept Path Summary With Profiles

Note: Inbound vessel piloted from conning station
Outbound vessel piloted from instructor station

Simulation #43 Swept Path Summary With Profiles

Note: Inbound vessel piloted from conning station
Outbound vessel piloted from instructor station
Buoys moved to simulate 800 ft channel



Simulation #44 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

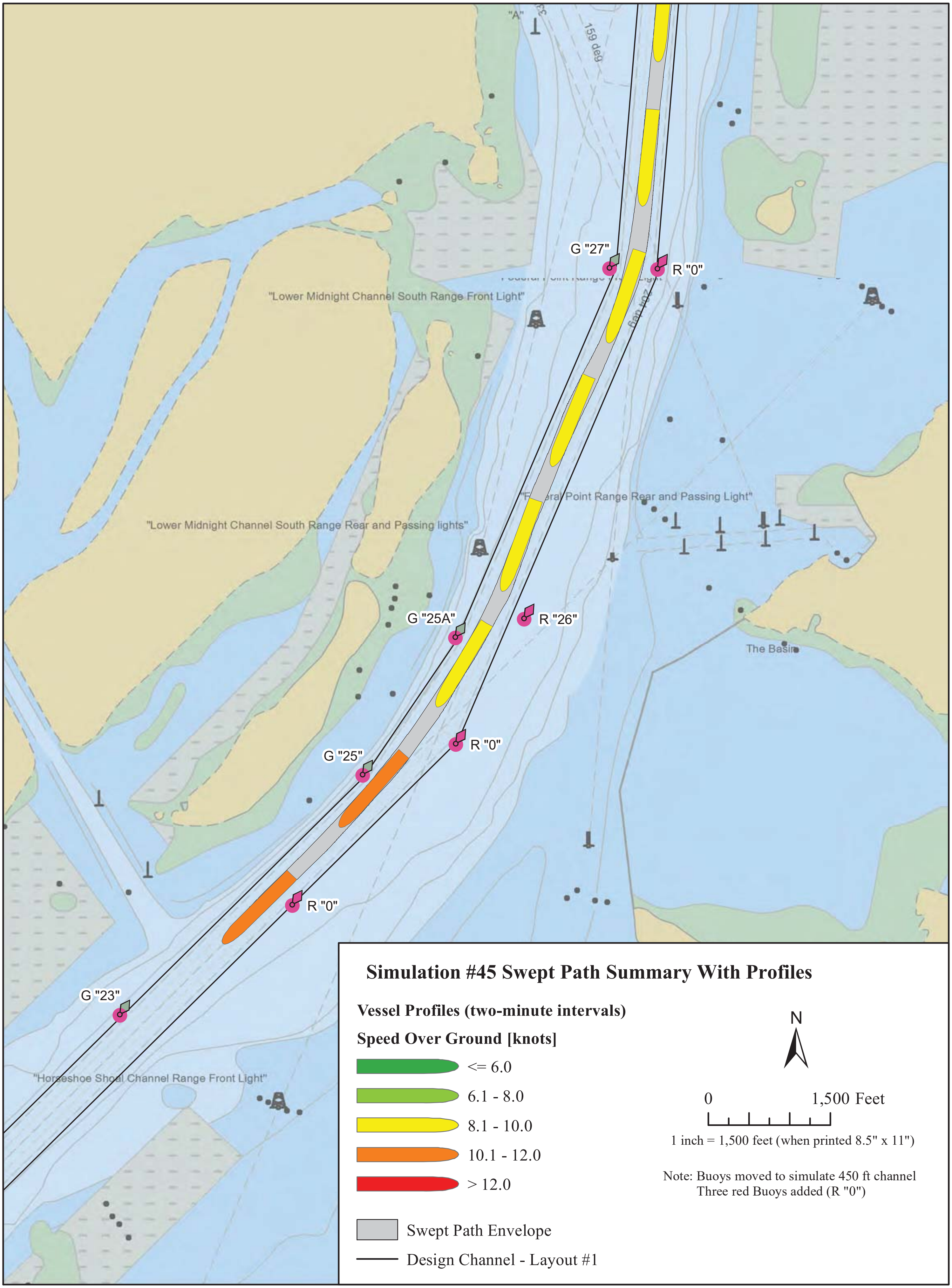
Speed Over Ground [knots]

🟩 <= 6.0
🟩 6.1 - 8.0
🟨 8.1 - 10.0
🟧 10.1 - 12.0
🟥 > 12.0

▨ Swept Path Envelope
— Design Channel - Layout #1

1 inch = 1,500 feet (when printed 8.5" x 11")

Note: Buoys moved to simulate 450 ft channel
Three red bouys added (R "0")



Simulation #45 Swept Path Summary With Profiles

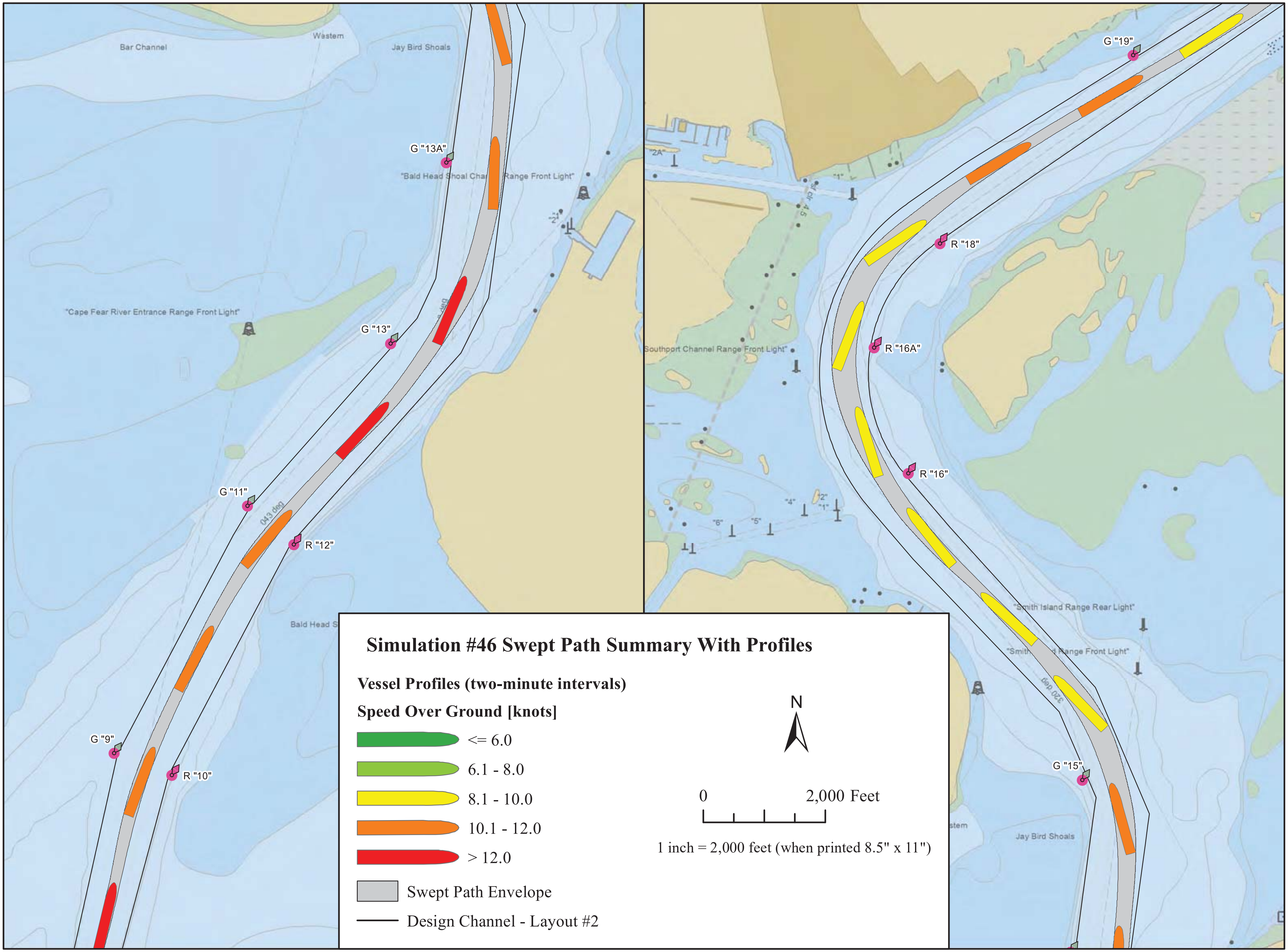
Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

🟩	<= 6.0
🟩	6.1 - 8.0
🟨	8.1 - 10.0
🟧	10.1 - 12.0
🟥	> 12.0
▨	Swept Path Envelope
—	Design Channel - Layout #1

1 inch = 1,500 feet (when printed 8.5" x 11")

Note: Buoys moved to simulate 450 ft channel
Three red Buoys added (R "0")



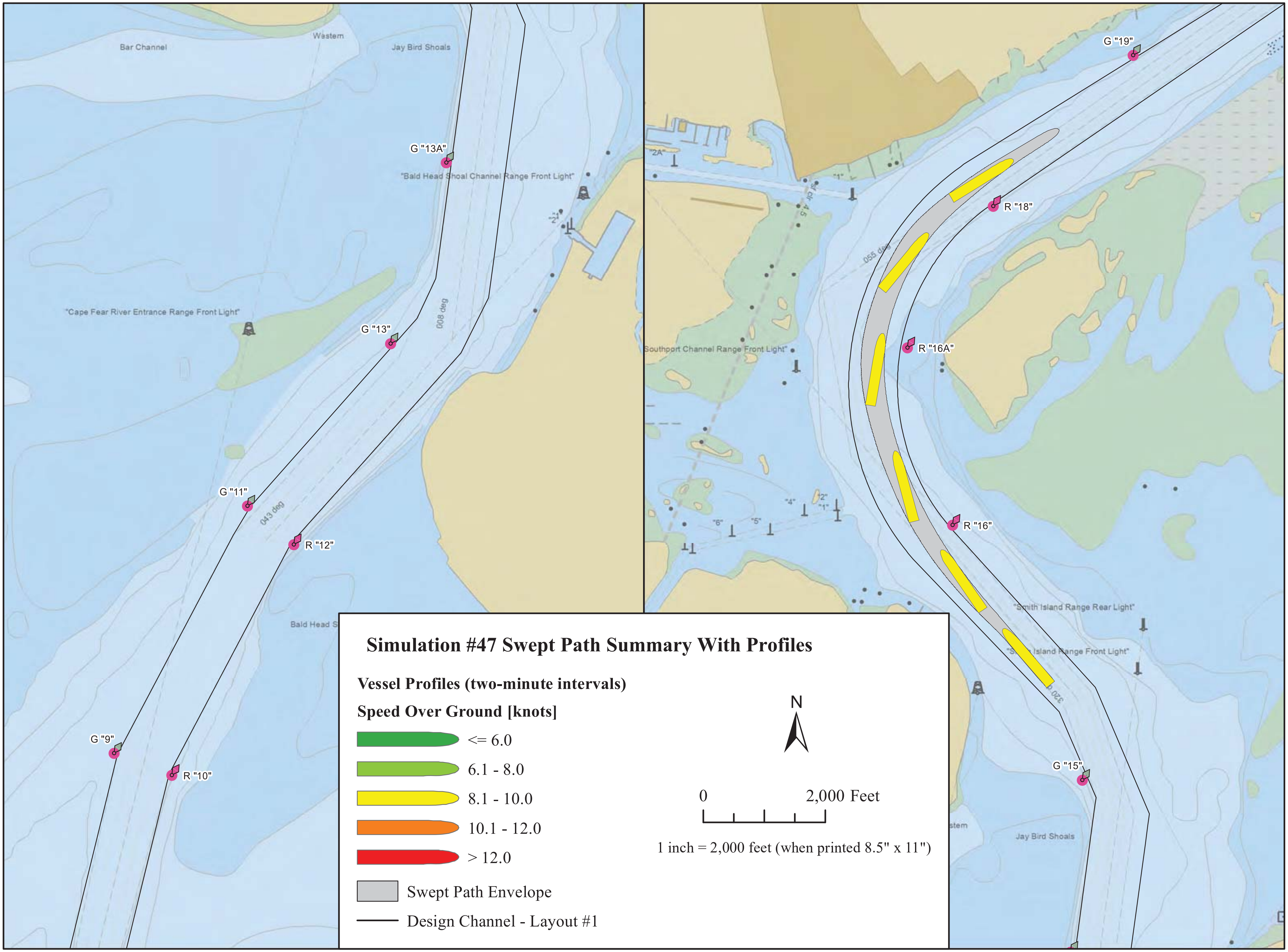
Simulation #46 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

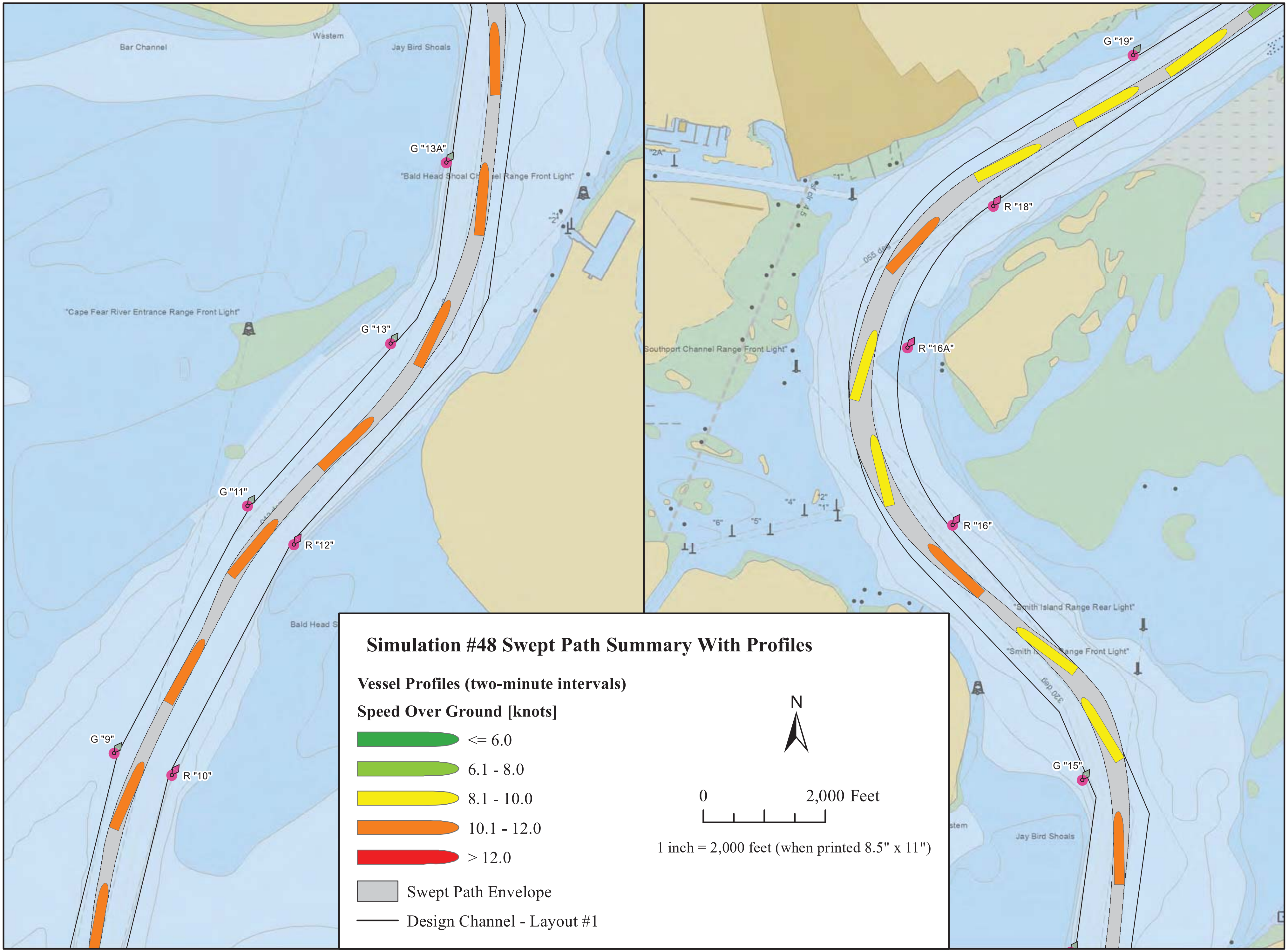
- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0
- ▨ Swept Path Envelope
- — Design Channel - Layout #2

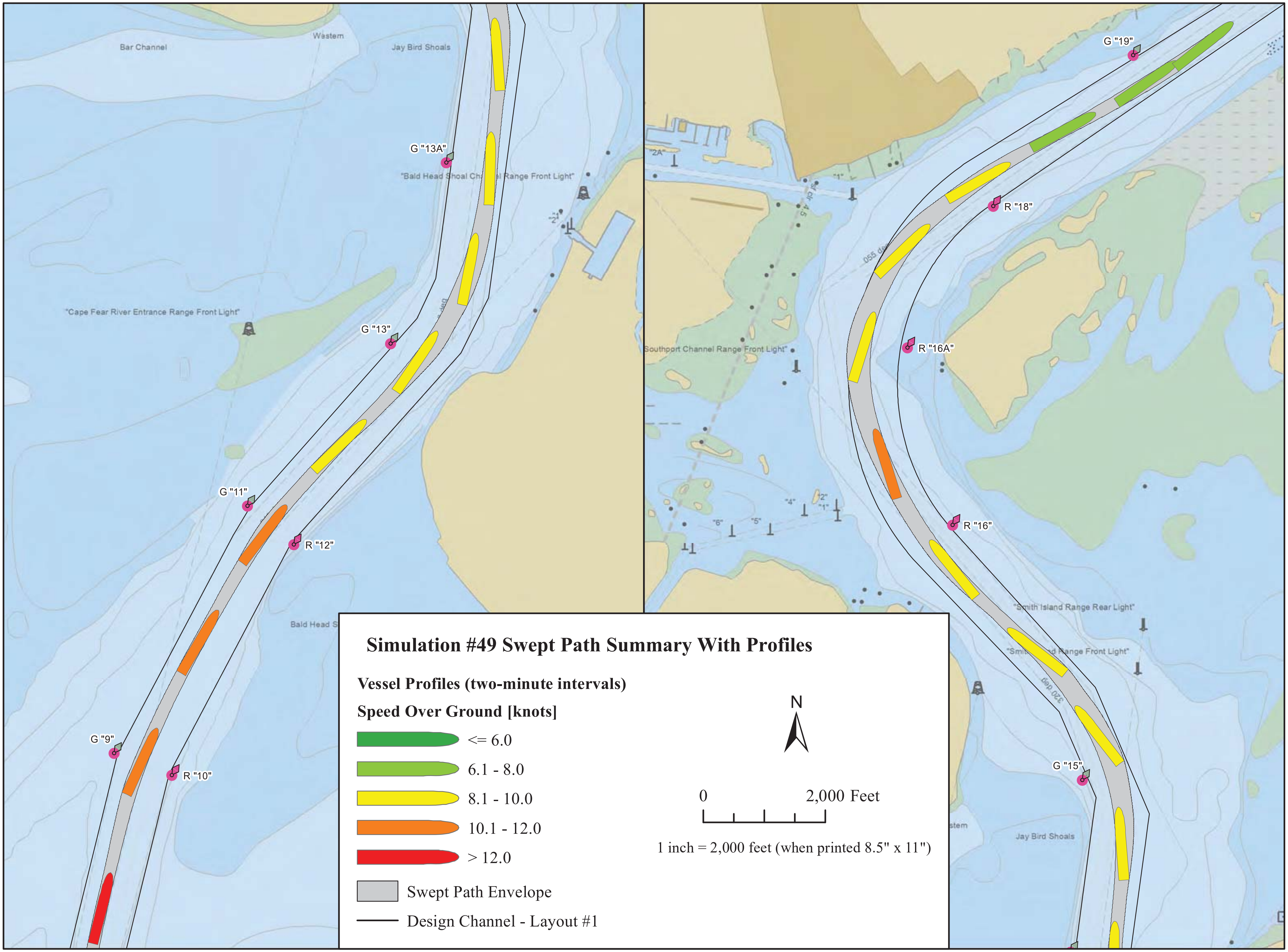
1 inch = 2,000 feet (when printed 8.5" x 11")



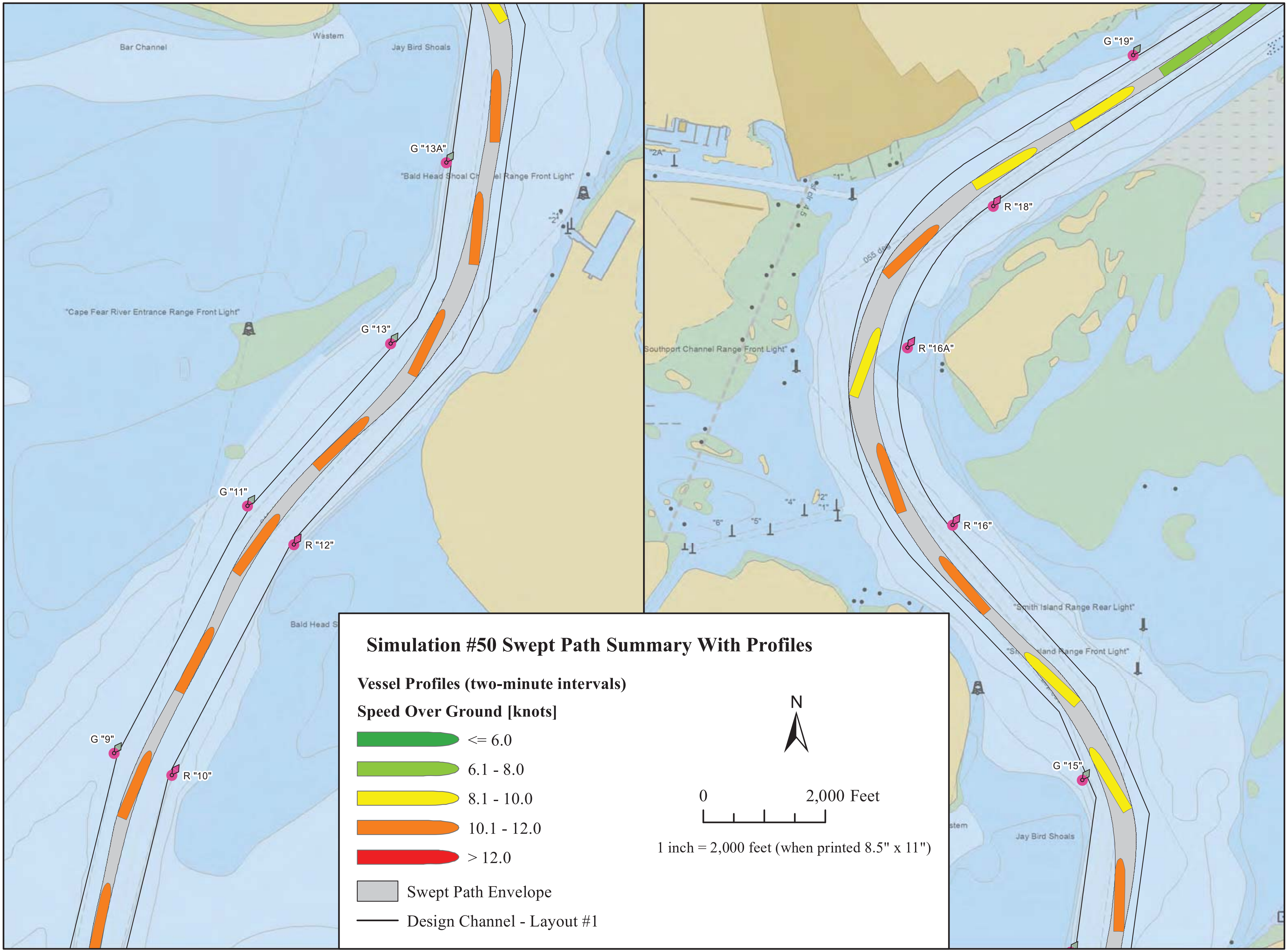
Simulation #47 Swept Path Summary With Profiles

Simulation #48 Swept Path Summary With Profiles

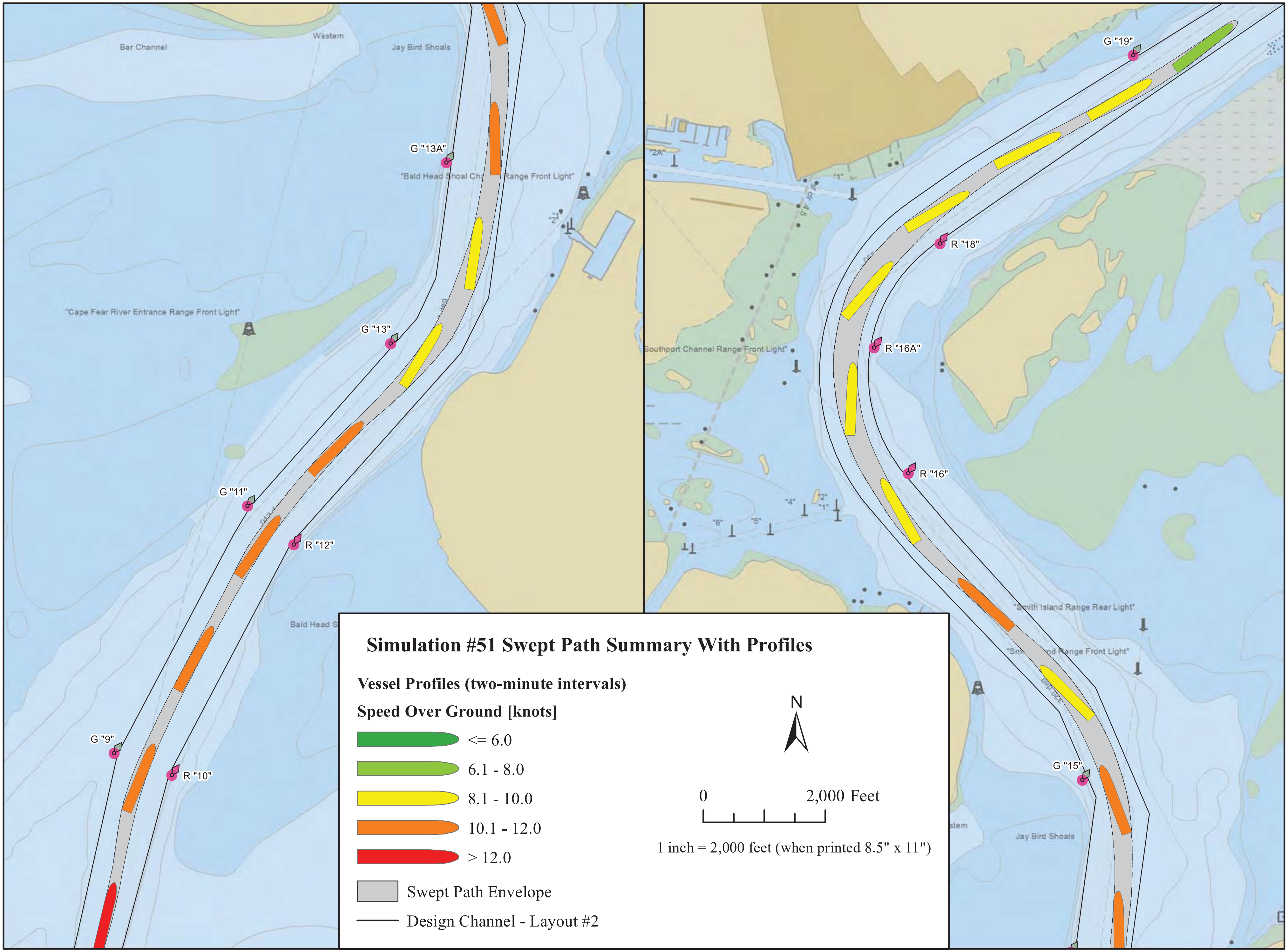




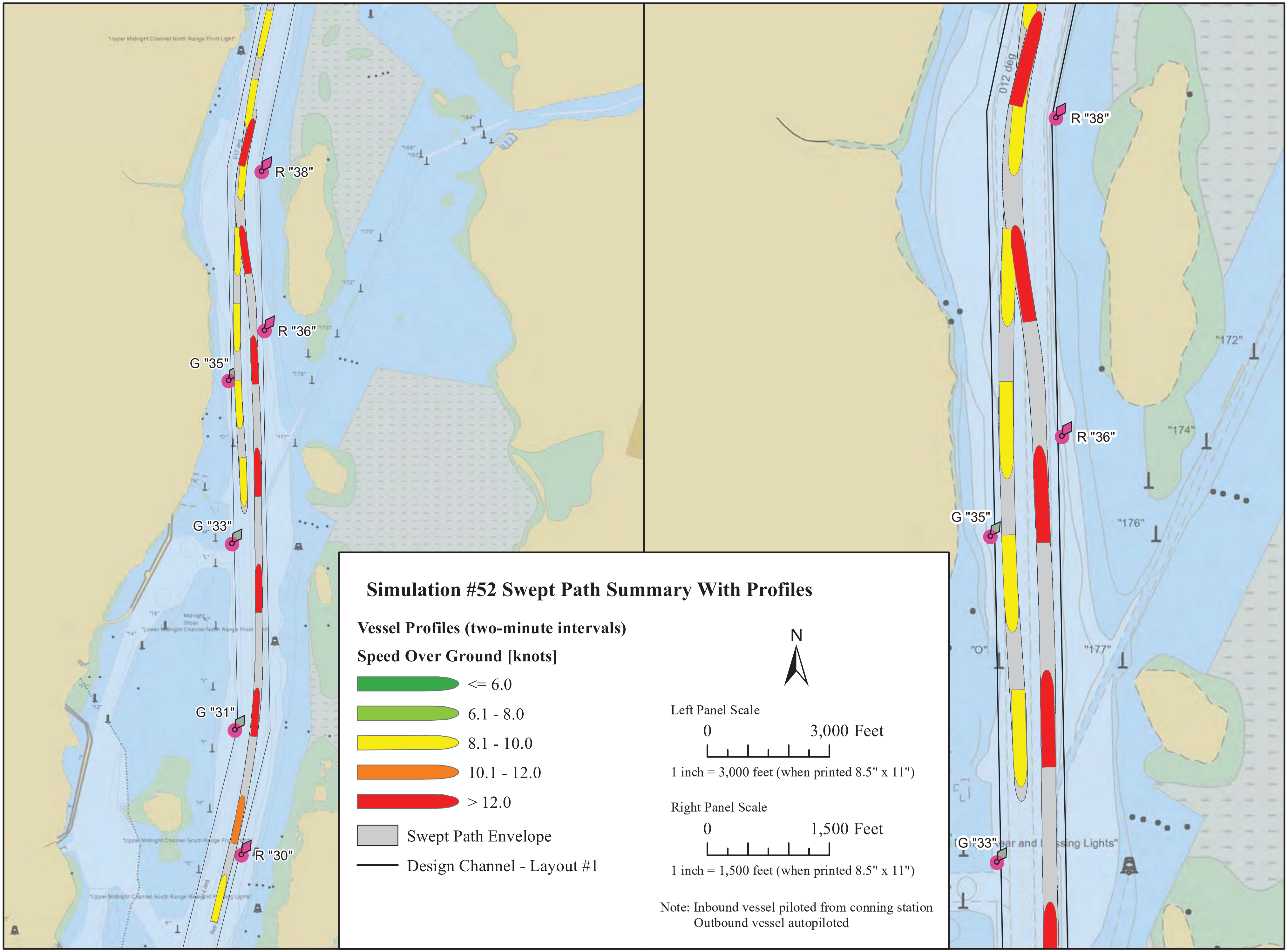
Simulation #49 Swept Path Summary With Profiles



Simulation #50 Swept Path Summary With Profiles



Simulation #51 Swept Path Summary With Profiles



Simulation #52 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)

Speed Over Ground [knots]

- 🟩 <= 6.0
- 🟩 6.1 - 8.0
- 🟨 8.1 - 10.0
- 🟧 10.1 - 12.0
- 🟥 > 12.0
- ▨ Swept Path Envelope
- — Design Channel - Layout #1

N

Left Panel Scale

0 3,000 Feet

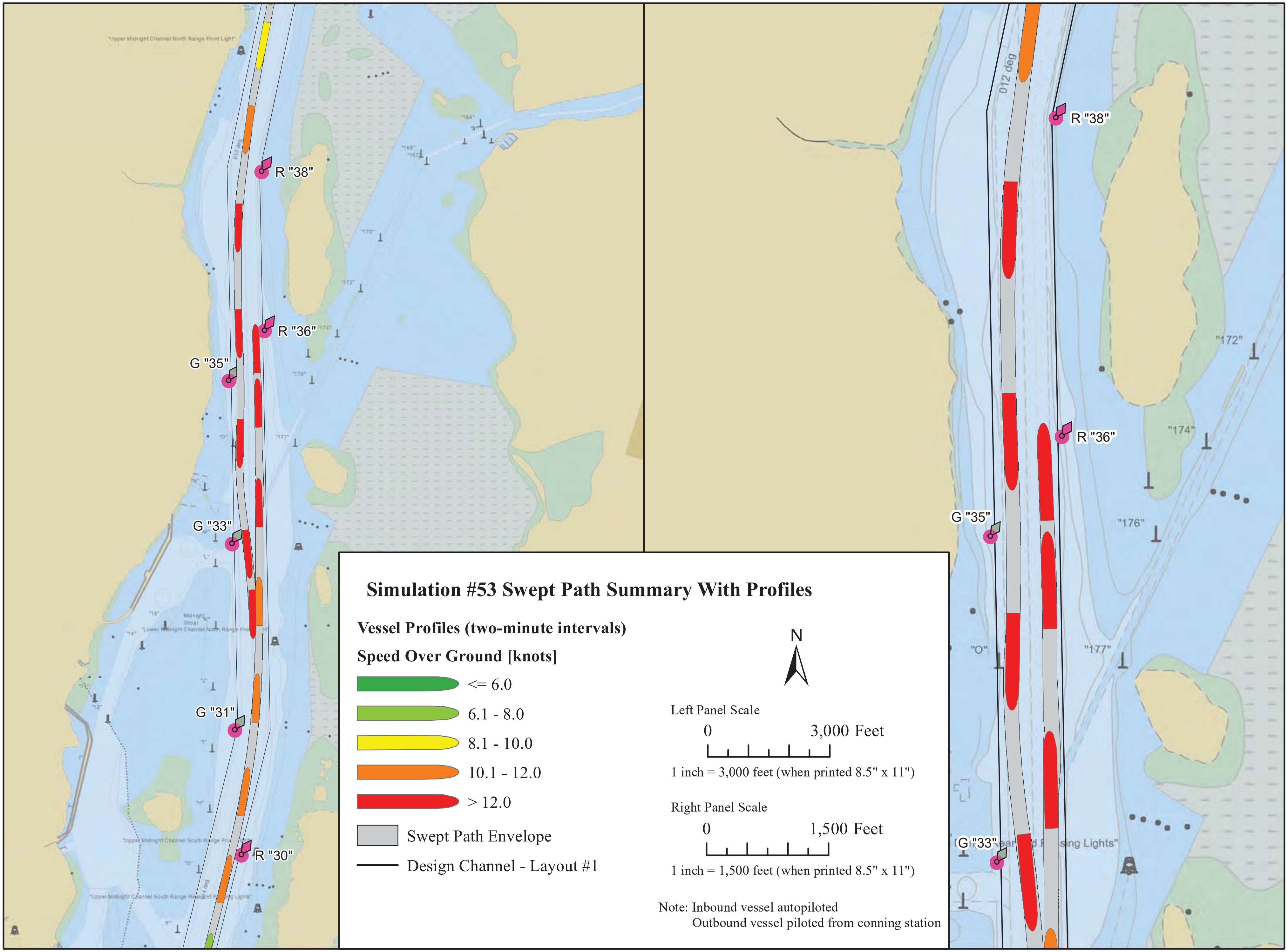
1 inch = 3,000 feet (when printed 8.5" x 11")

Right Panel Scale

0 1,500 Feet

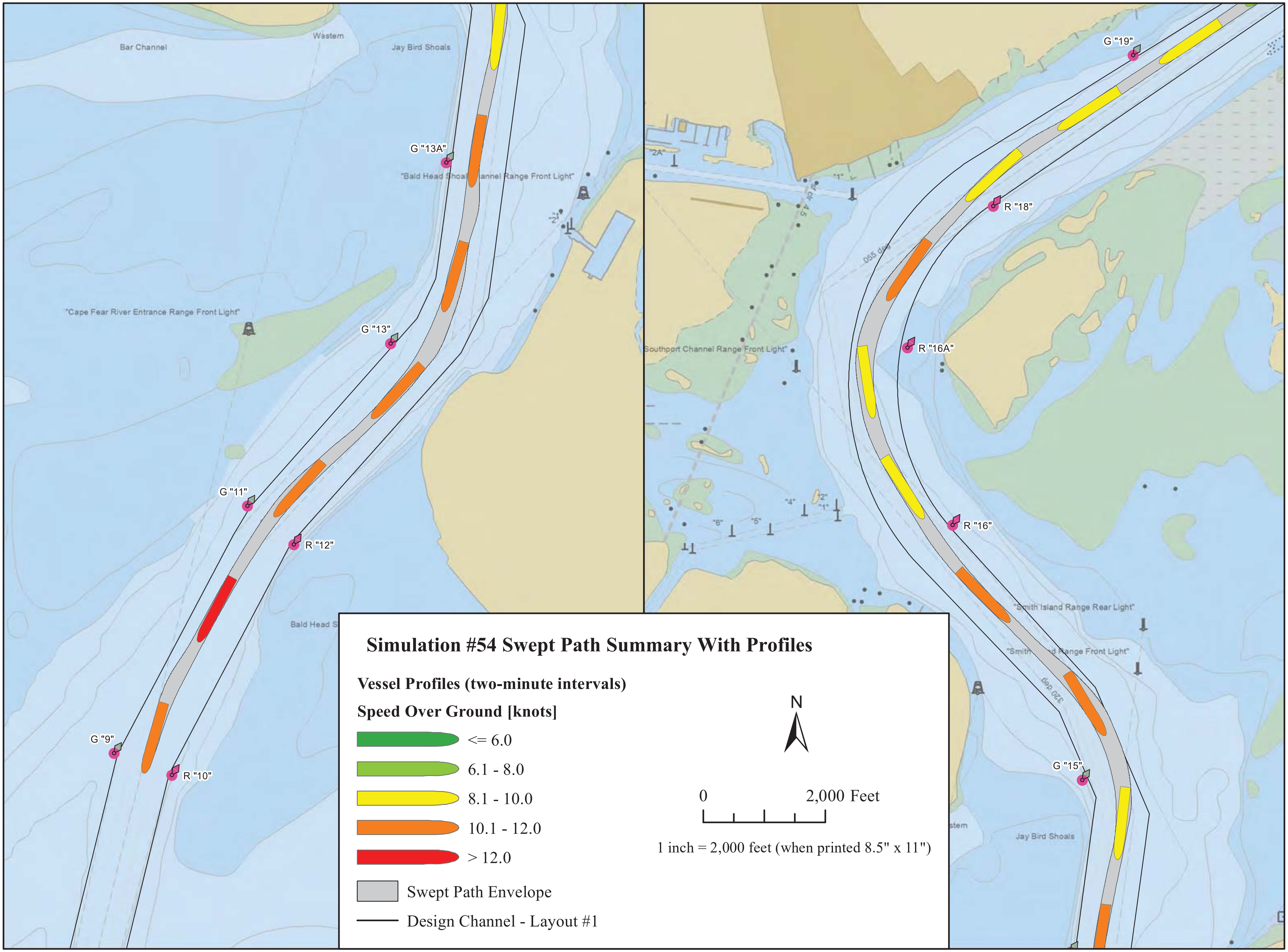
1 inch = 1,500 feet (when printed 8.5" x 11")

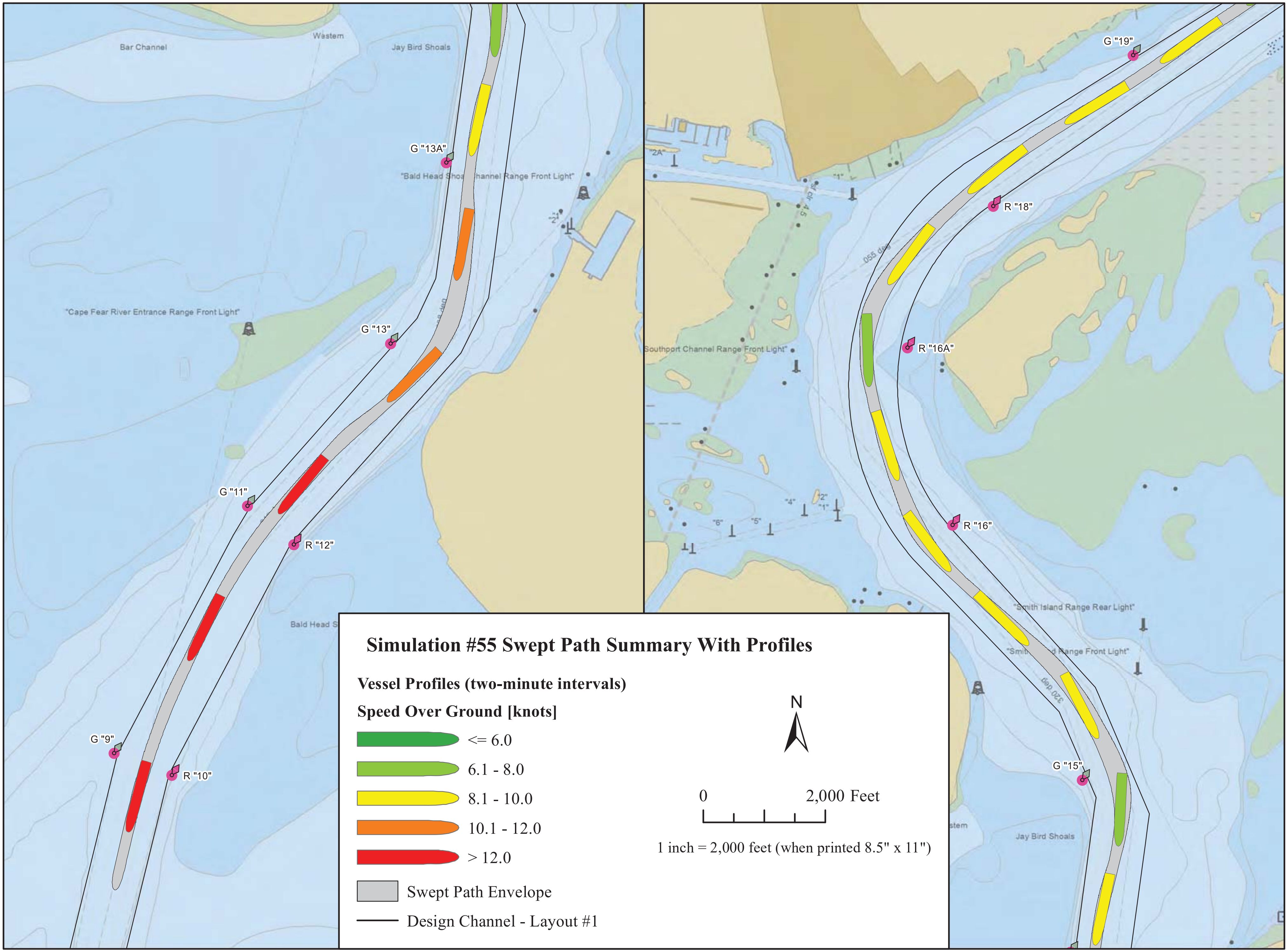
Note: Inbound vessel piloted from conning station
Outbound vessel autopiloted



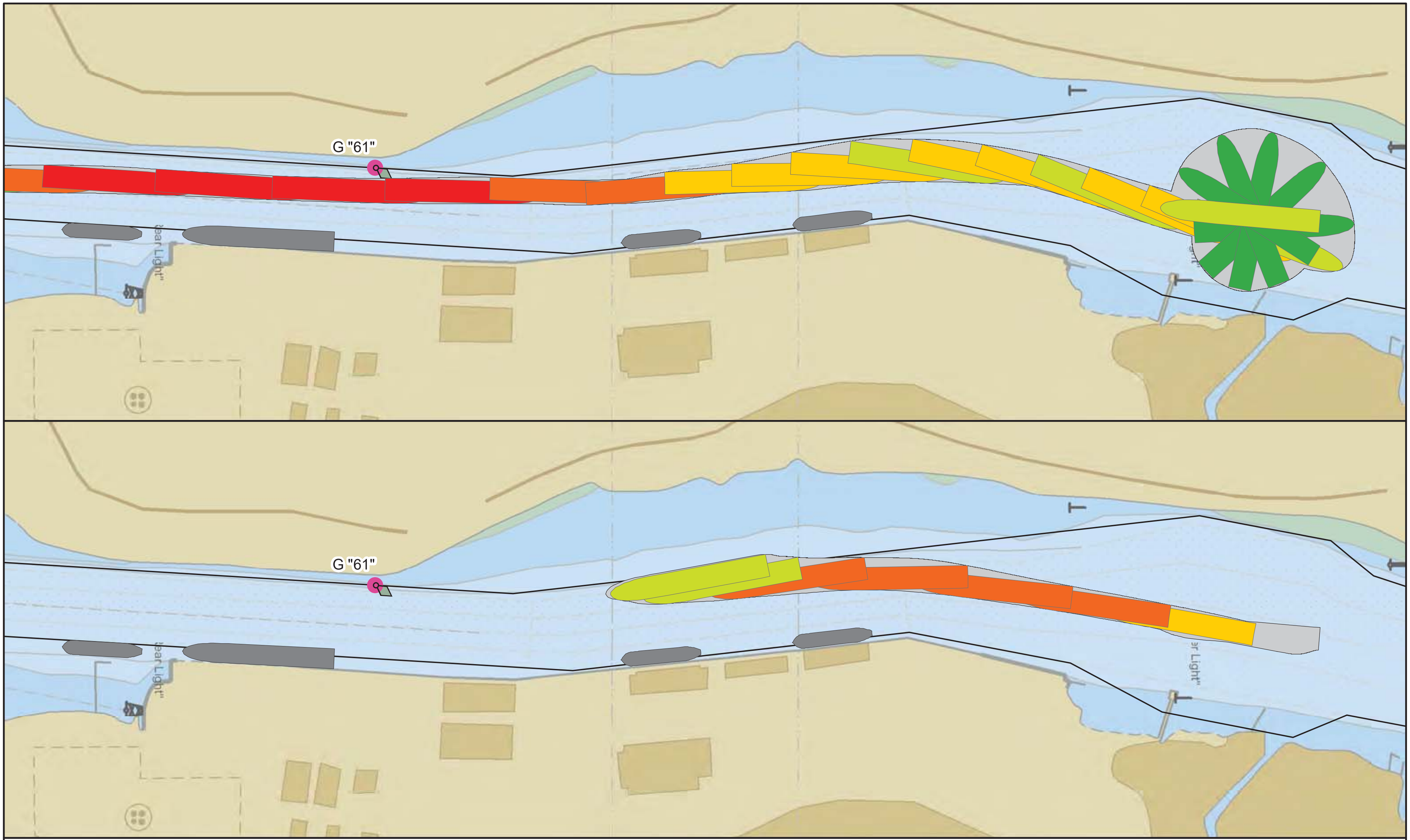
Simulation #53 Swept Path Summary With Profiles

Note: Inbound vessel autopiloted
Outbound vessel piloted from conning station


Bar Channel
Wastem
Jay Bird Shoals
G "13A"
"Bald Head Shoal Channel Range Front Light"
"1"
"2"
"Cape Fear River Entrance Range Front Light"
G "13"
G "11"
R "12"
Bald Head S
G "9"
R "10"
G "19"
"2A"
"1"
sf clr 4.5
R "18"
055 deg
Southport Channel Range Front Light"
R "16A"
"4"
"2"
"1"
"6"
"5"
R "16"
"Smith Island Range Rear Light"
"Smith Island Range Front Light"
320 deg
G "15"
stem
Jay Bird Shoals
Simulation #54 Swept Path Summary With Profiles
Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]
<= 6.0
6.1 - 8.0
8.1 - 10.0
10.1 - 12.0
> 12.0
Swept Path Envelope
Design Channel - Layout #1
N
0
2,000 Feet
1 inch = 2,000 feet (when printed 8.5" x 11")



Simulation #55 Swept Path Summary With Profiles



Simulation #58 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]

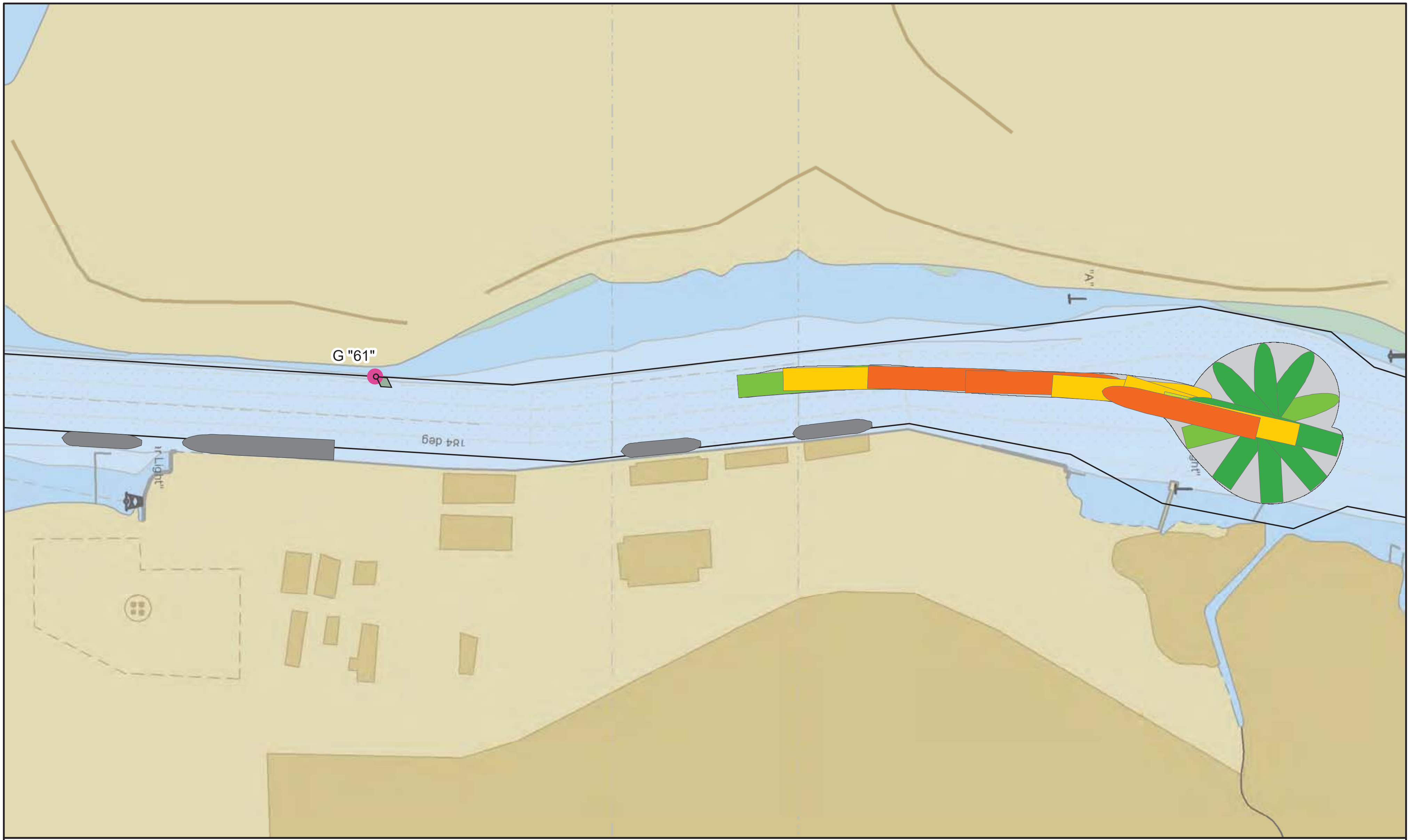
- <= 0.5
- 0.6 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- \> 4.0

- ▨ Swept Path Envelope
- ■ Moored Vessels
- — Design Channel - Layout #1

0 1,000 Feet

1 inch = 1,000 feet (when printed 8.5" x 11")

N



Simulation #59 Swept Path Summary With Profiles

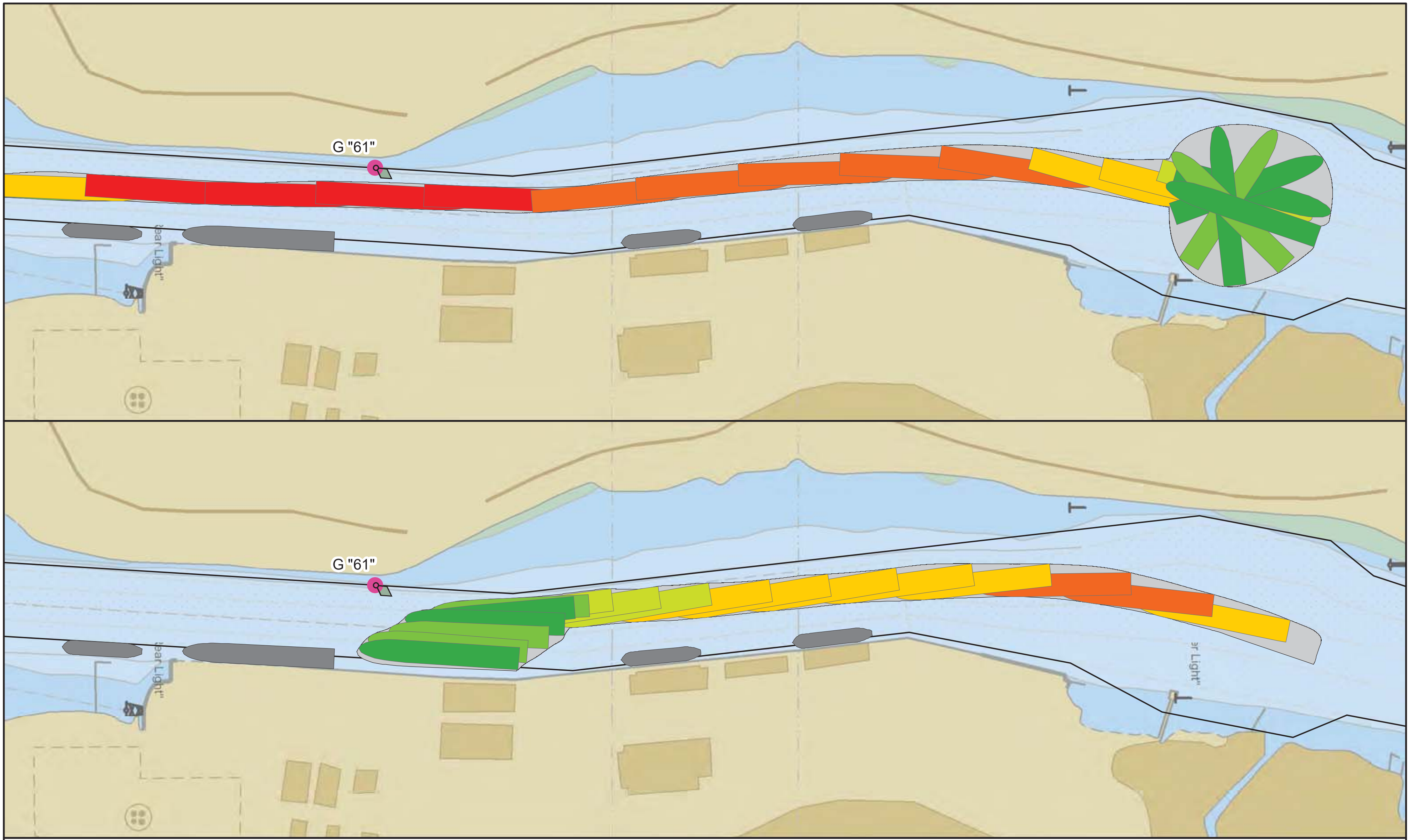
Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]

🟩 <= 0.5
🟩 0.6 - 1.0
🟨 1.1 - 2.0
🟨 2.1 - 3.0
🟧 3.1 - 4.0
🟥 > 4.0

▨ Swept Path Envelope
▨ Moored Vessels
— Design Channel - Layout #1

0 1,000 Feet
1 inch = 1,000 feet (when printed 8.5" x 11")

N



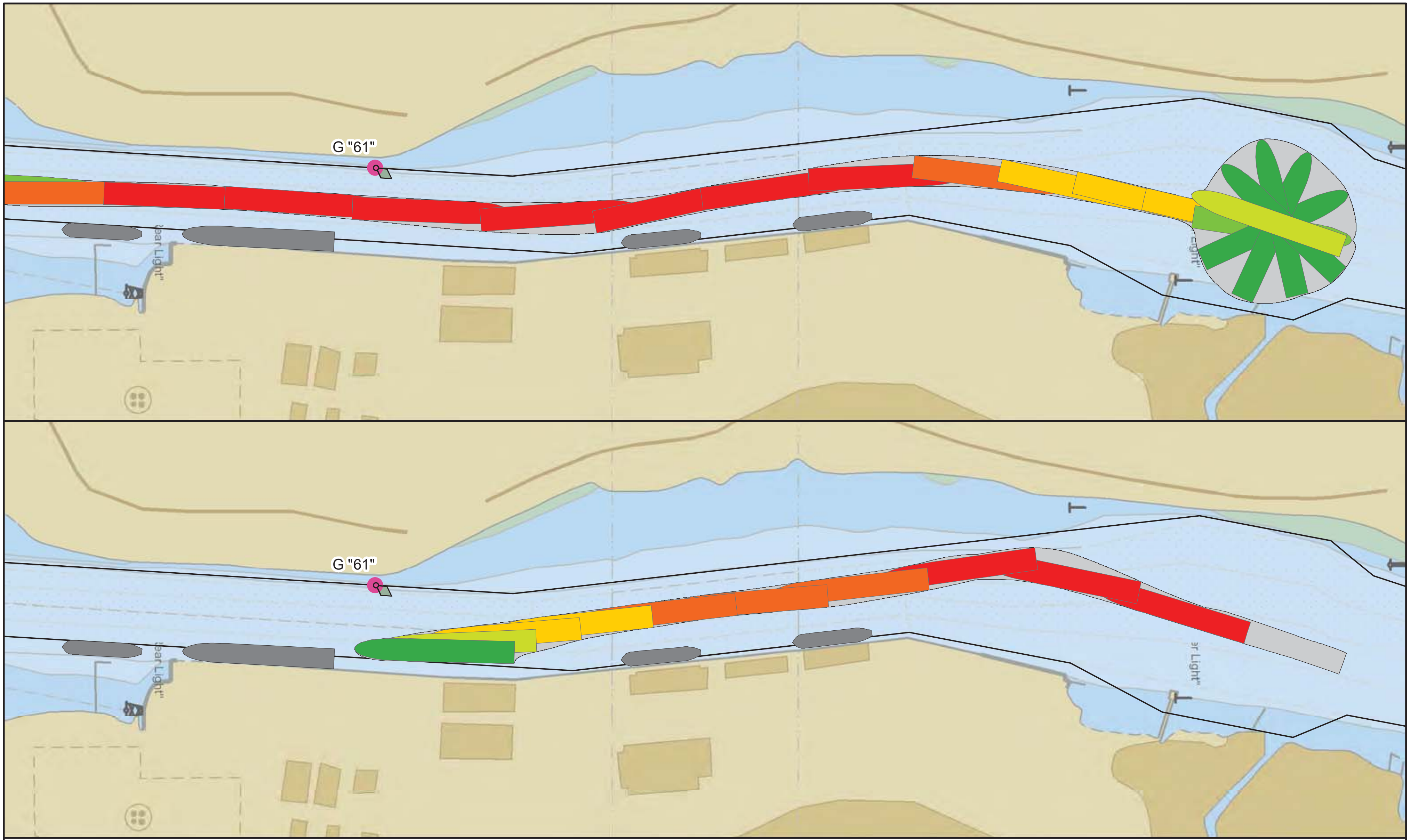
Simulation #60 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]

- 🟩 <= 0.5
- 🟩 0.6 - 1.0
- 🟩 1.1 - 2.0
- 🟨 2.1 - 3.0
- 🟧 3.1 - 4.0
- 🟥 > 4.0

- ⬜ Swept Path Envelope
- ⬛ Moored Vessels
- — Design Channel - Layout #1

1 inch = 1,000 feet (when printed 8.5" x 11")



Simulation #61 Swept Path Summary With Profiles

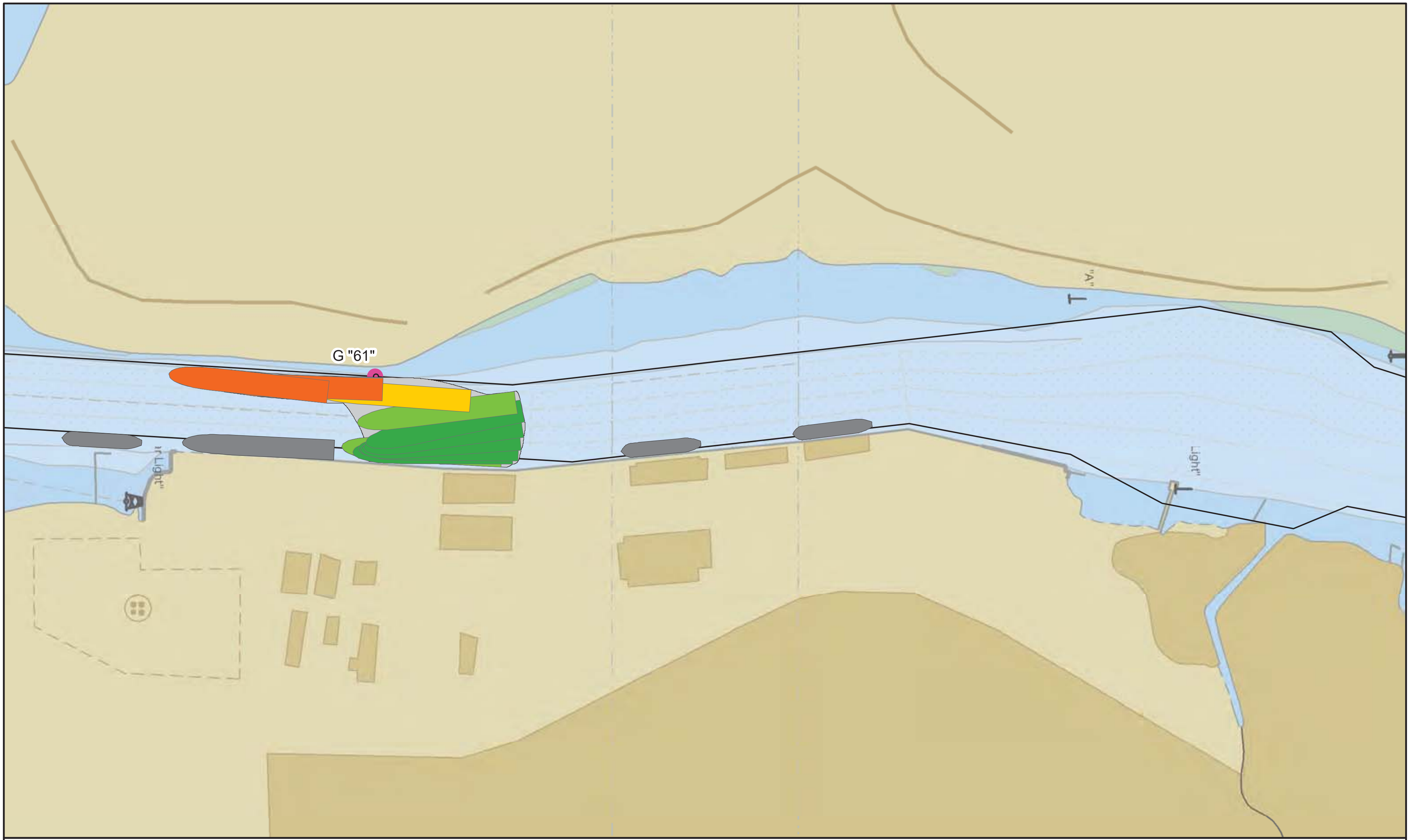
Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]

🟩 <= 0.5
🟩 0.6 - 1.0
🟨 1.1 - 2.0
🟨 2.1 - 3.0
🟧 3.1 - 4.0
🟥 > 4.0

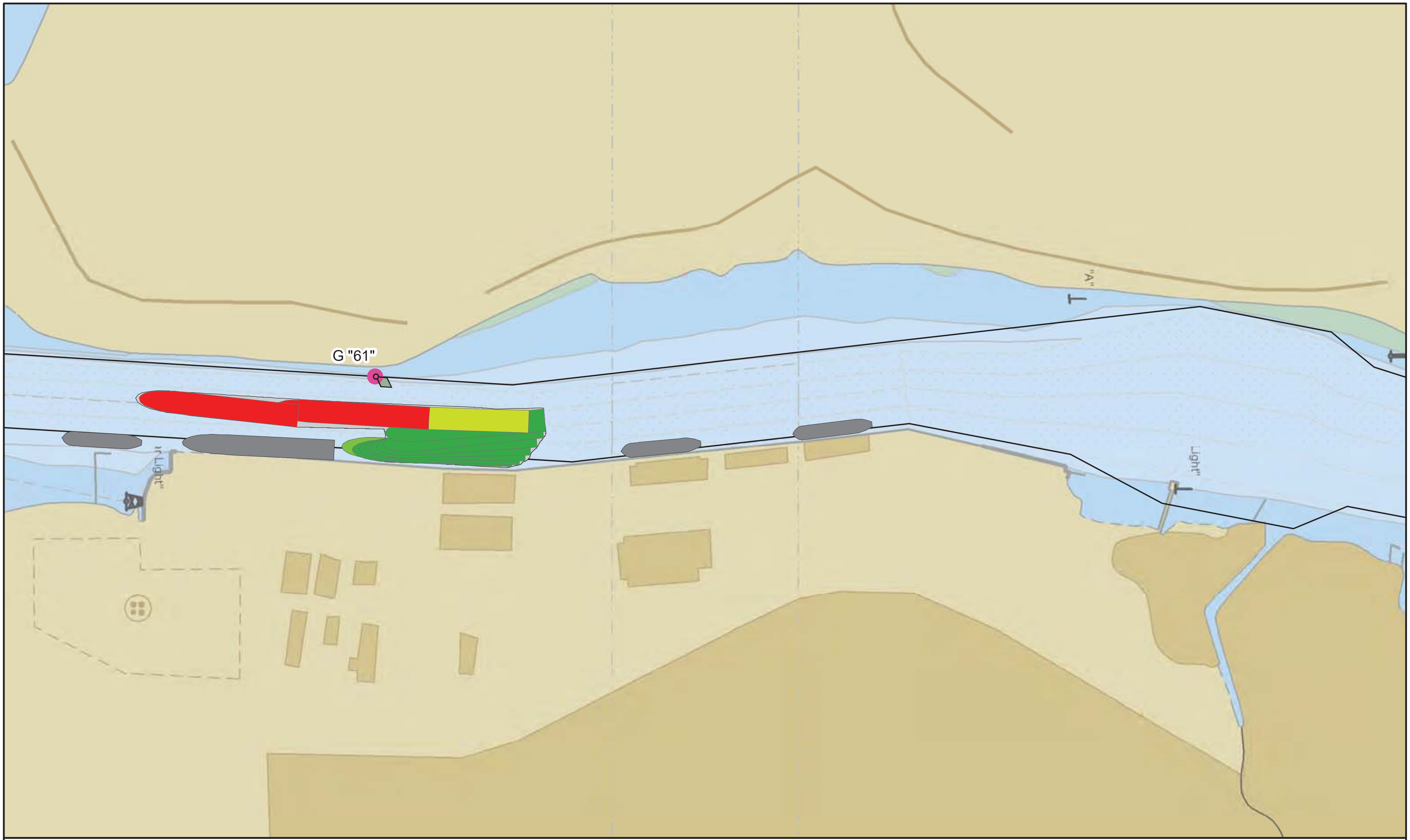
▨ Swept Path Envelope
▨ Moored Vessels
— Design Channel - Layout #1

0 1,000 Feet
1 inch = 1,000 feet (when printed 8.5" x 11")

N



Simulation #62 Swept Path Summary With Profiles



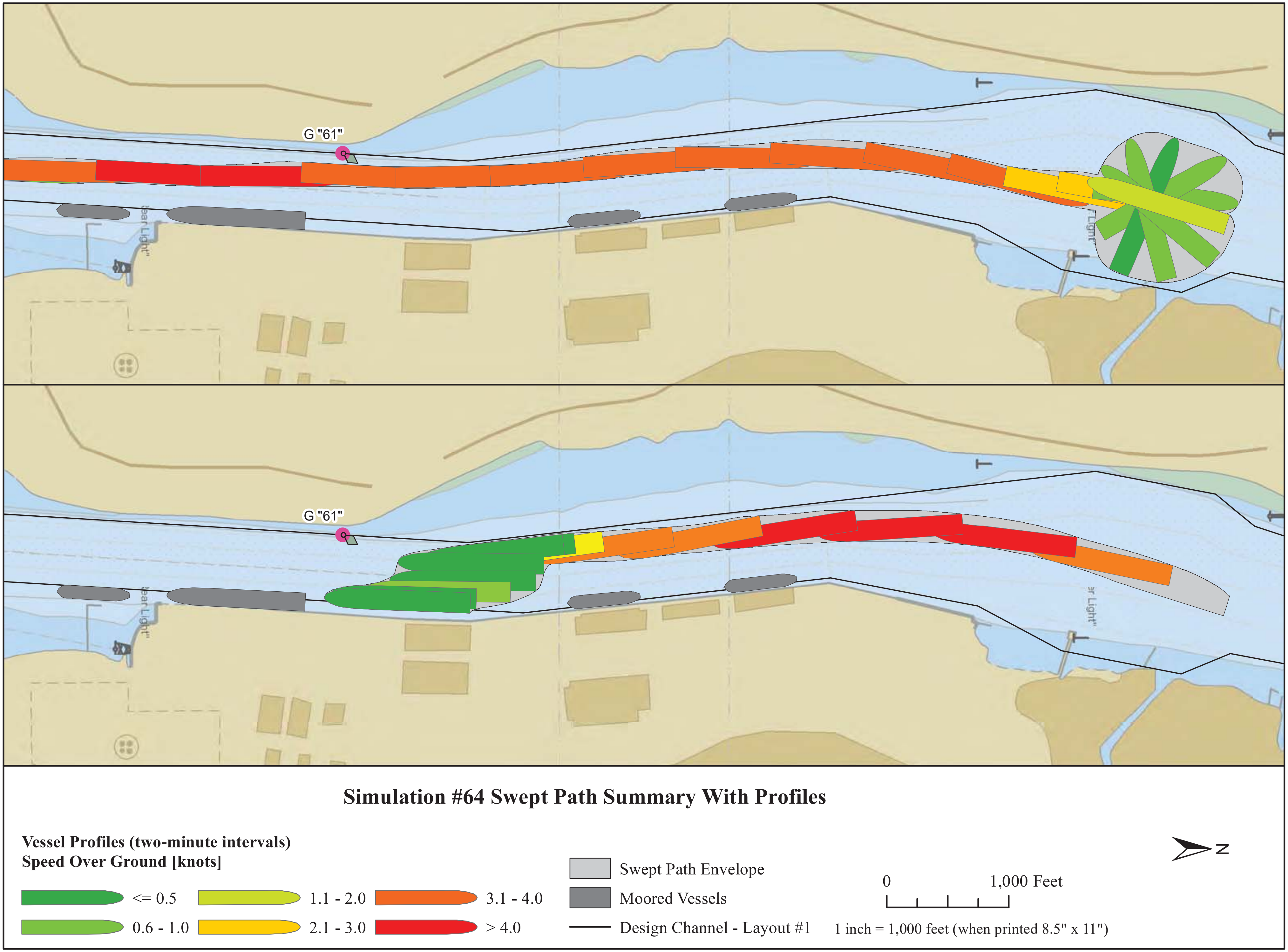
Simulation #63 Swept Path Summary With Profiles

Vessel Profiles (two-minute intervals)
Speed Over Ground [knots]

- 🟩 <= 0.5
- 🟩 0.6 - 1.0
- 🟨 1.1 - 2.0
- 🟨 2.1 - 3.0
- 🟧 3.1 - 4.0
- 🟥 > 4.0

- ▭ Swept Path Envelope
- ■ Moored Vessels
- — Design Channel - Layout #1

1 inch = 1,000 feet (when printed 8.5" x 11")



Simulation #64 Swept Path Summary With Profiles

Appendix B–5:
Station and Time History Figures of Key Simulation Parameters

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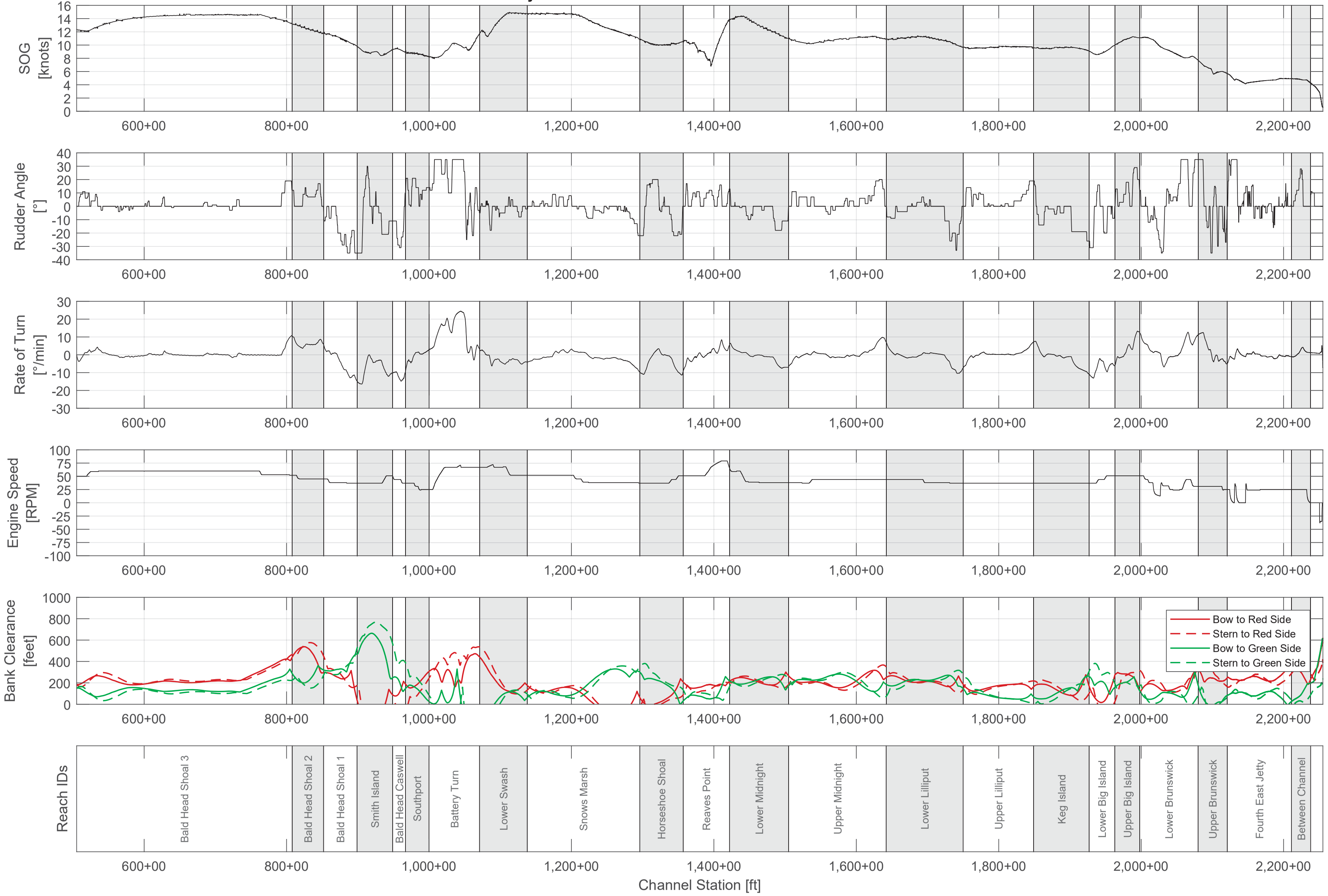
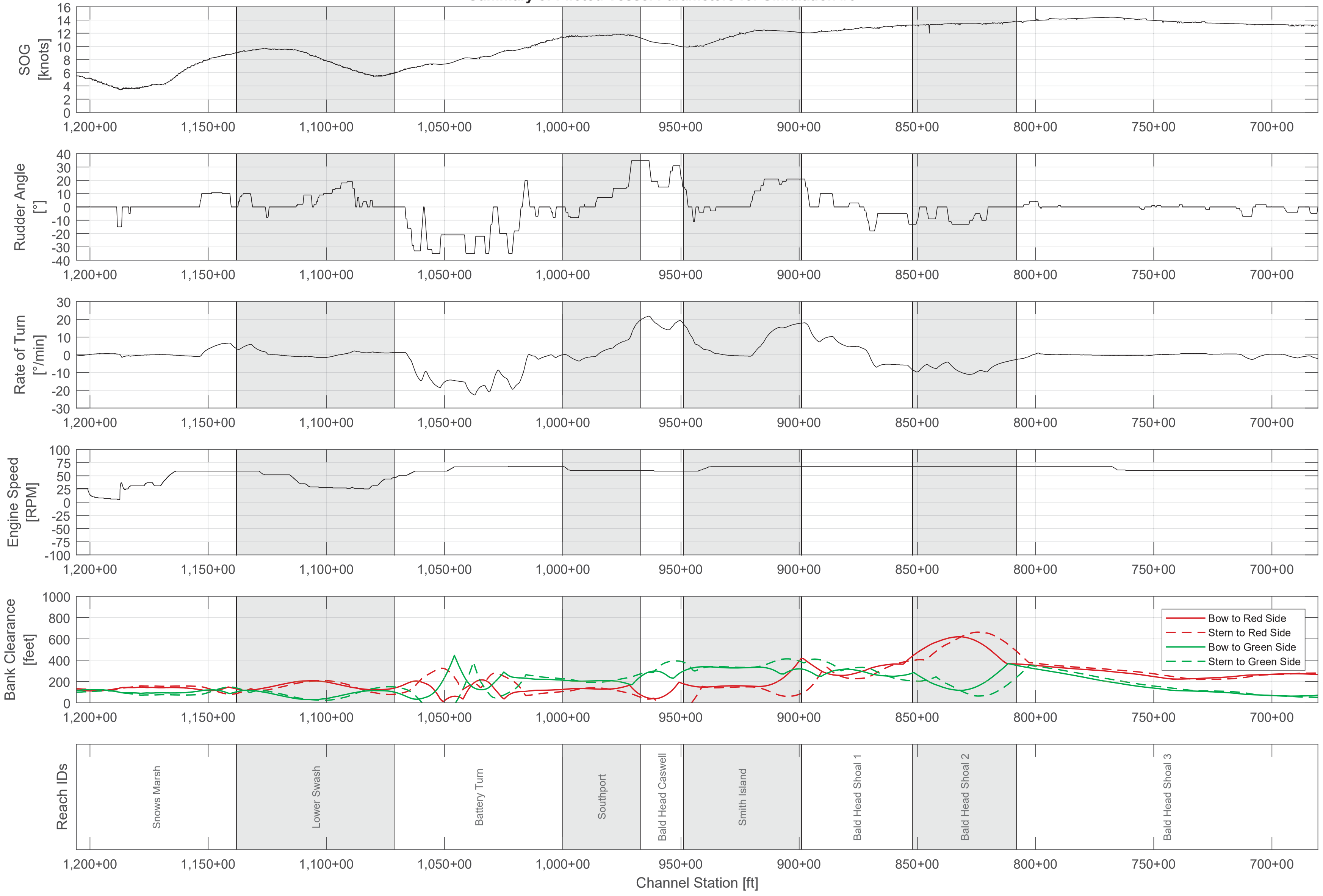
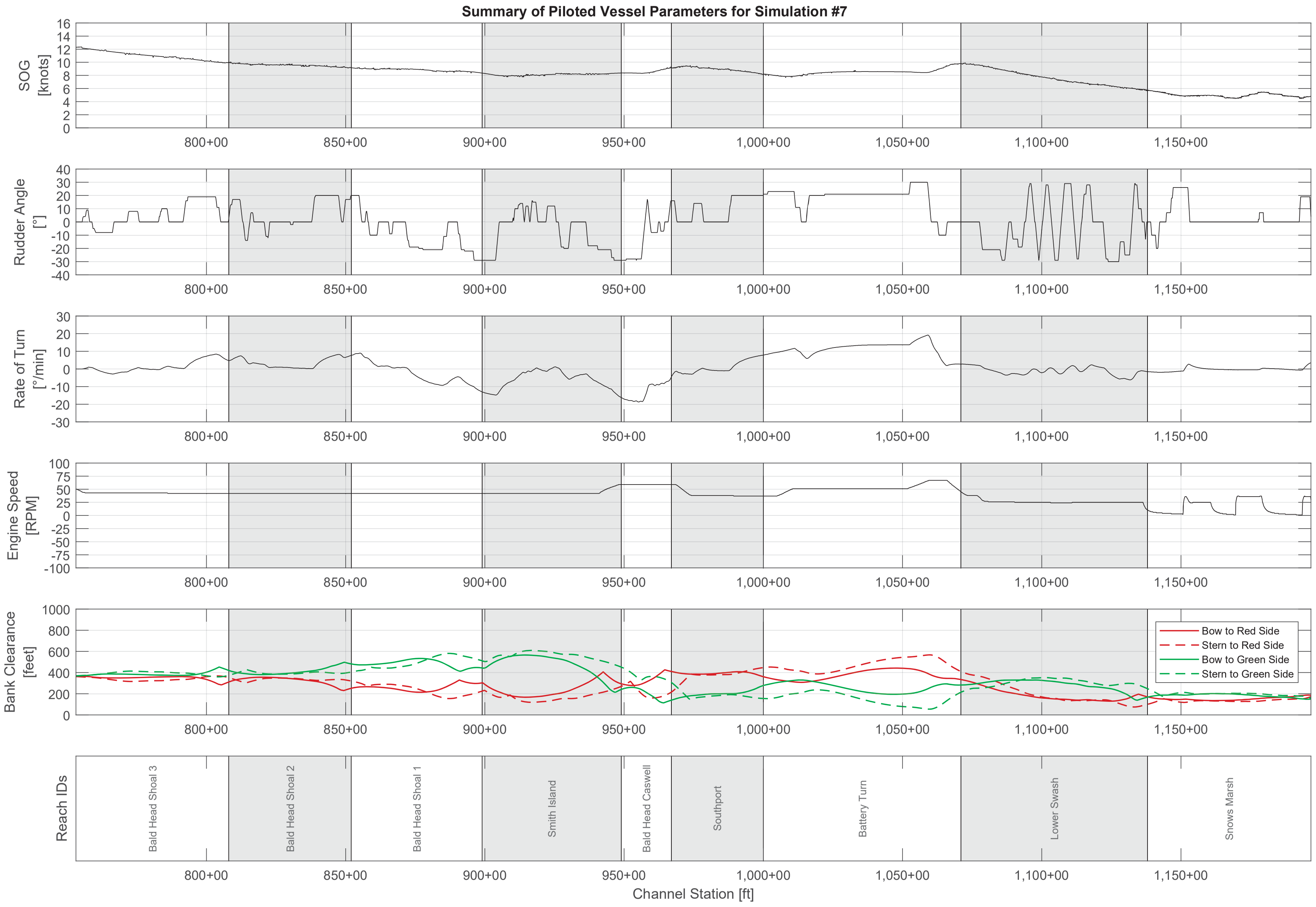
Summary of Piloted Vessel Parameters for Simulation #5

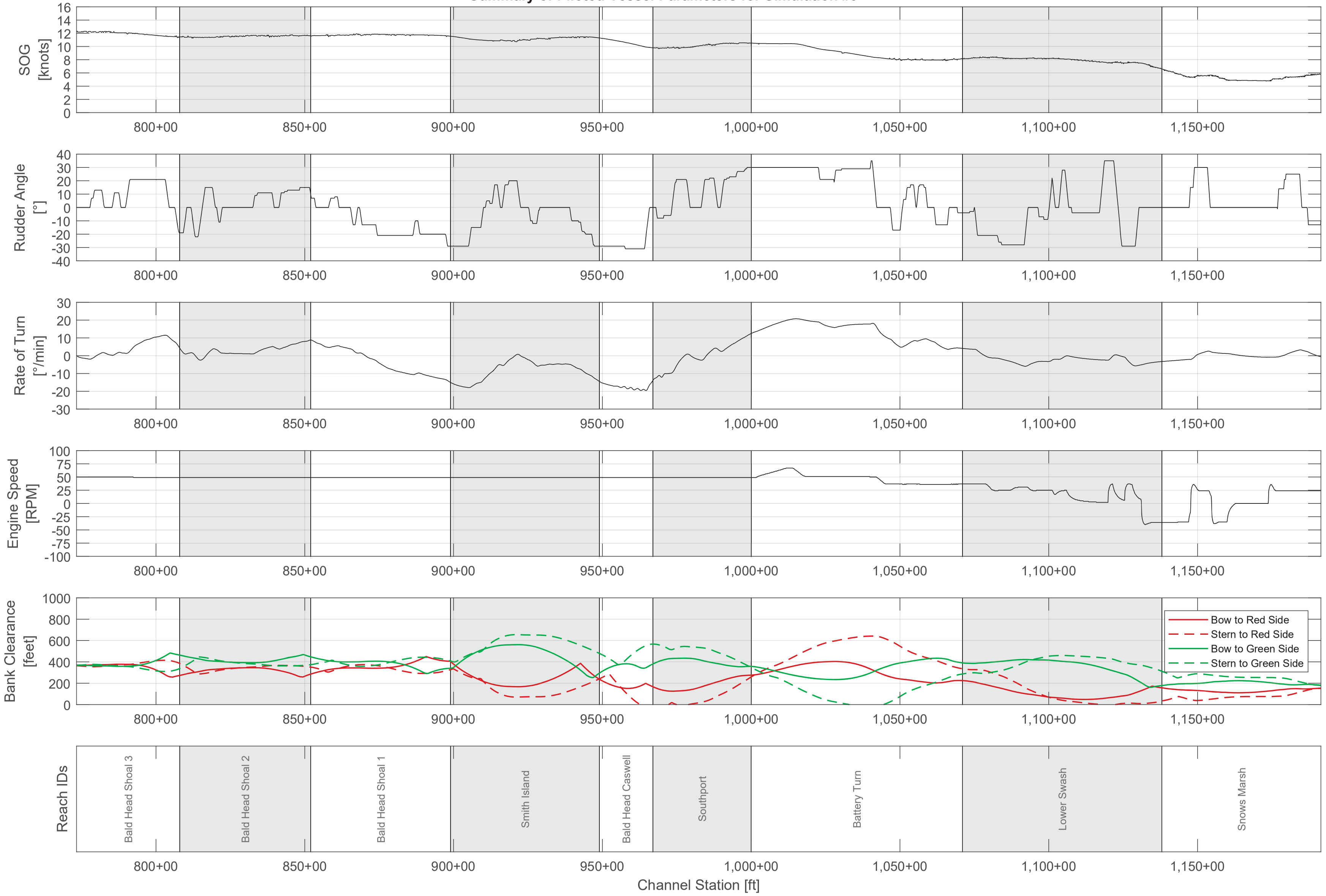


Summary of Piloted Vessel Parameters for Simulation #6

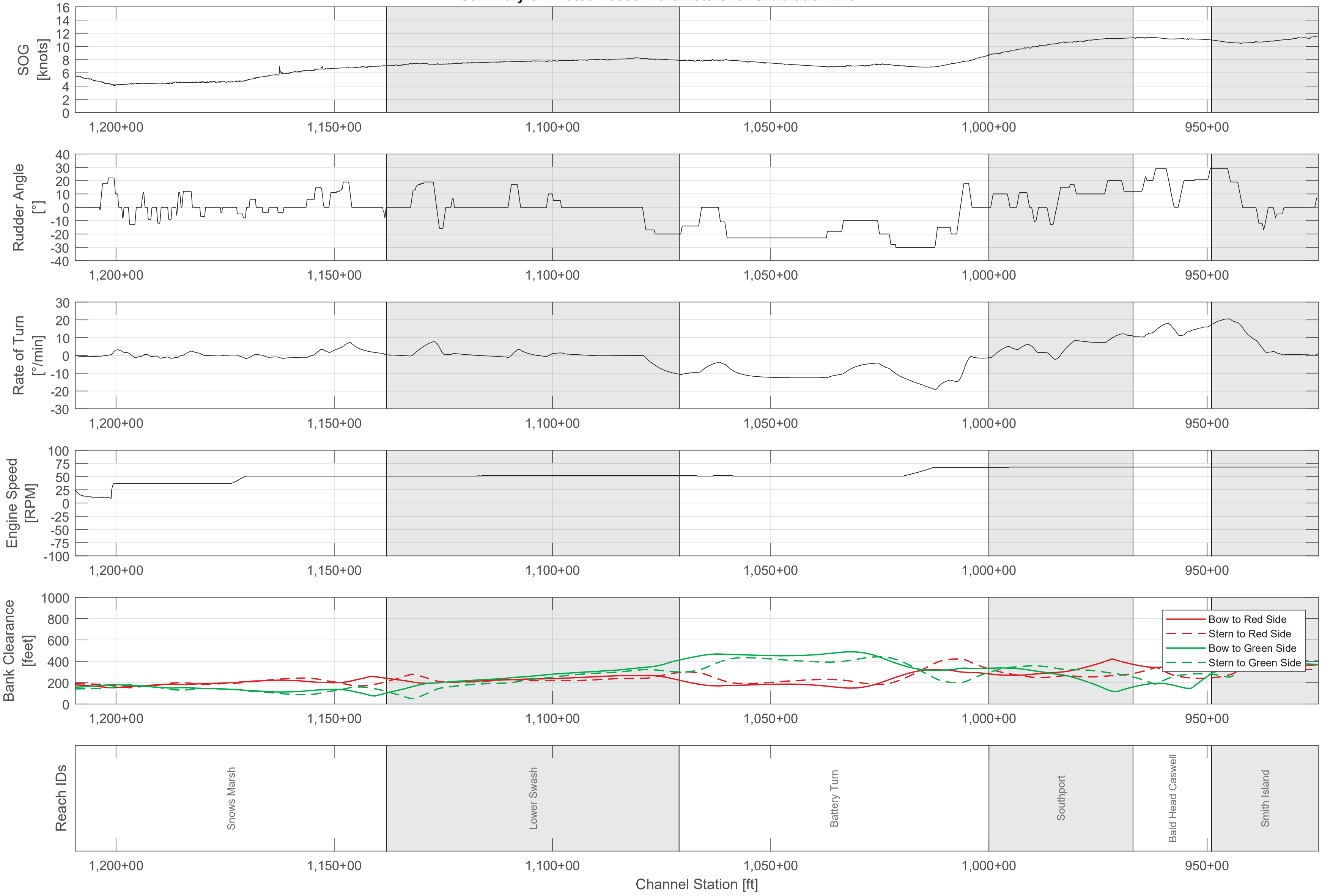



Summary of Piloted Vessel Parameters for Simulation #7

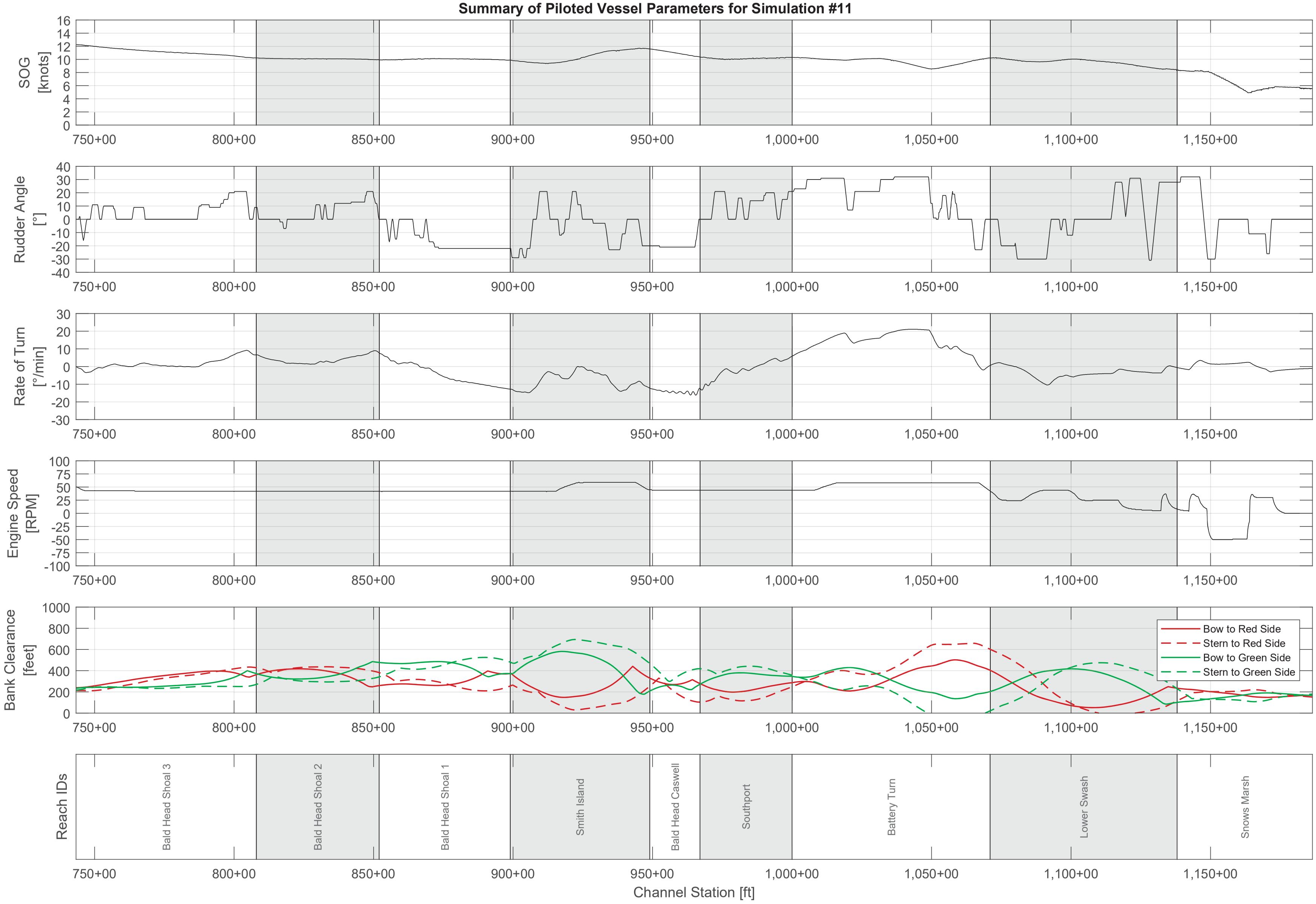
Summary of Piloted Vessel Parameters for Simulation #9



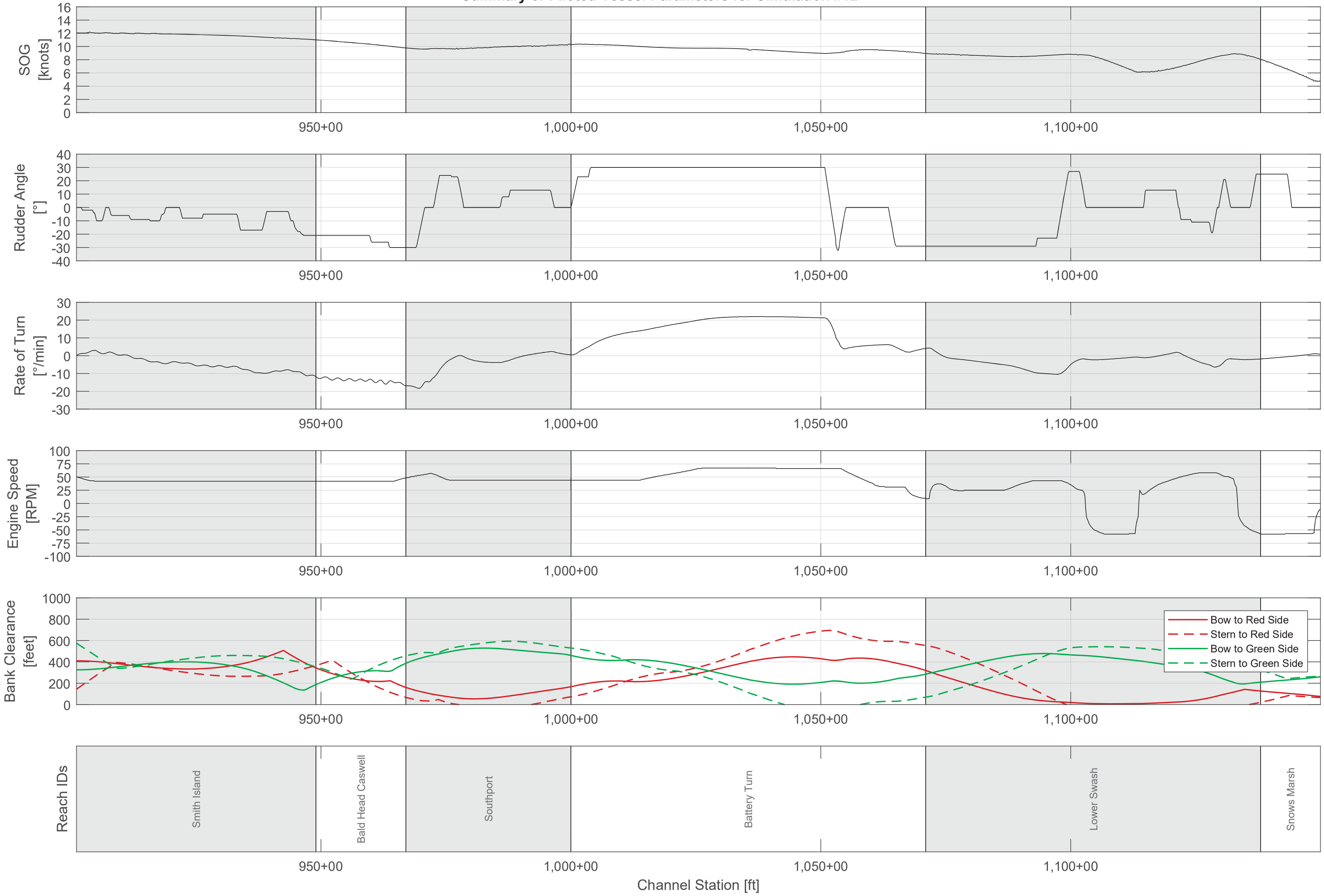
Summary of Piloted Vessel Parameters for Simulation #10



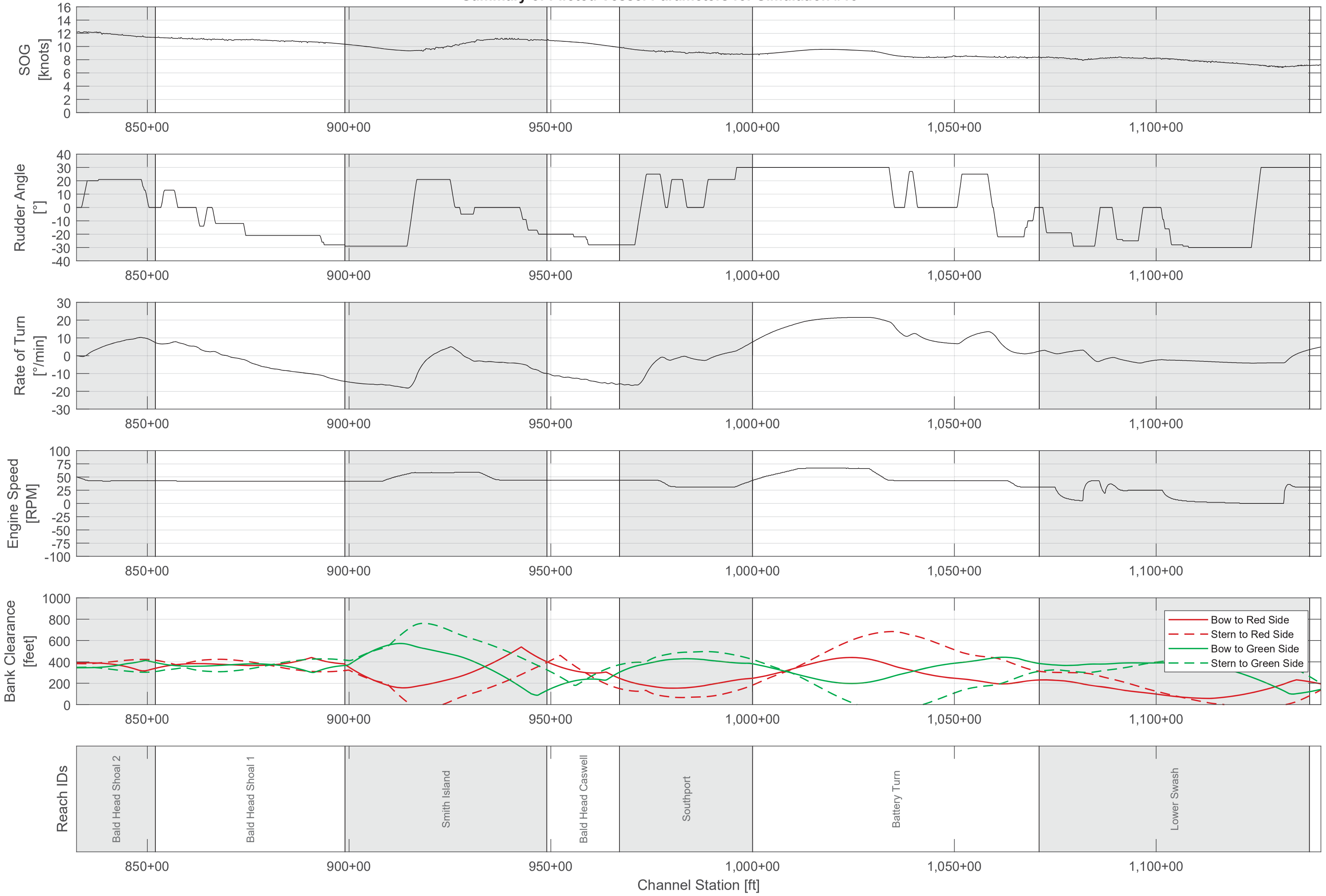
Summary of Piloted Vessel Parameters for Simulation #11



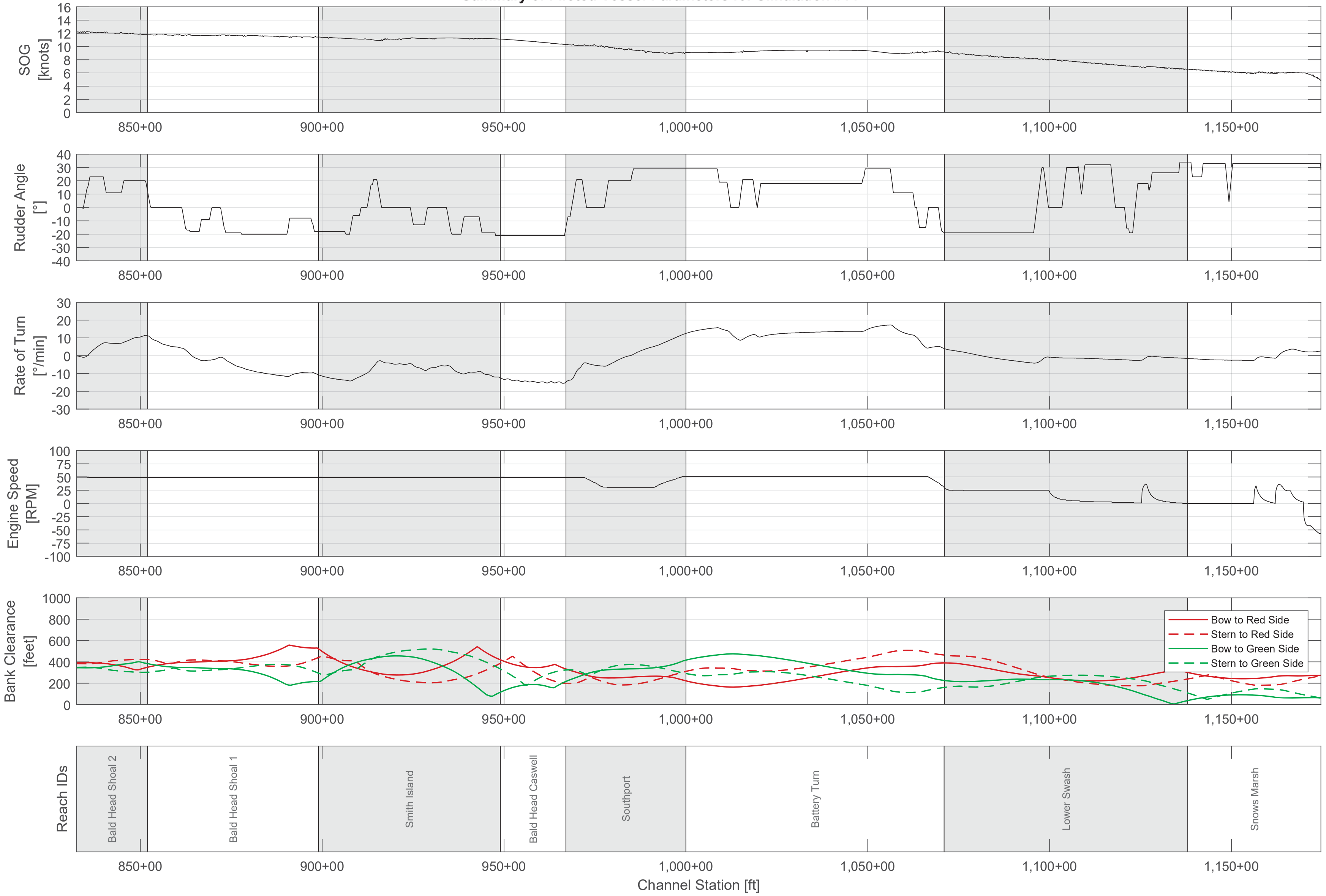
Summary of Piloted Vessel Parameters for Simulation #12

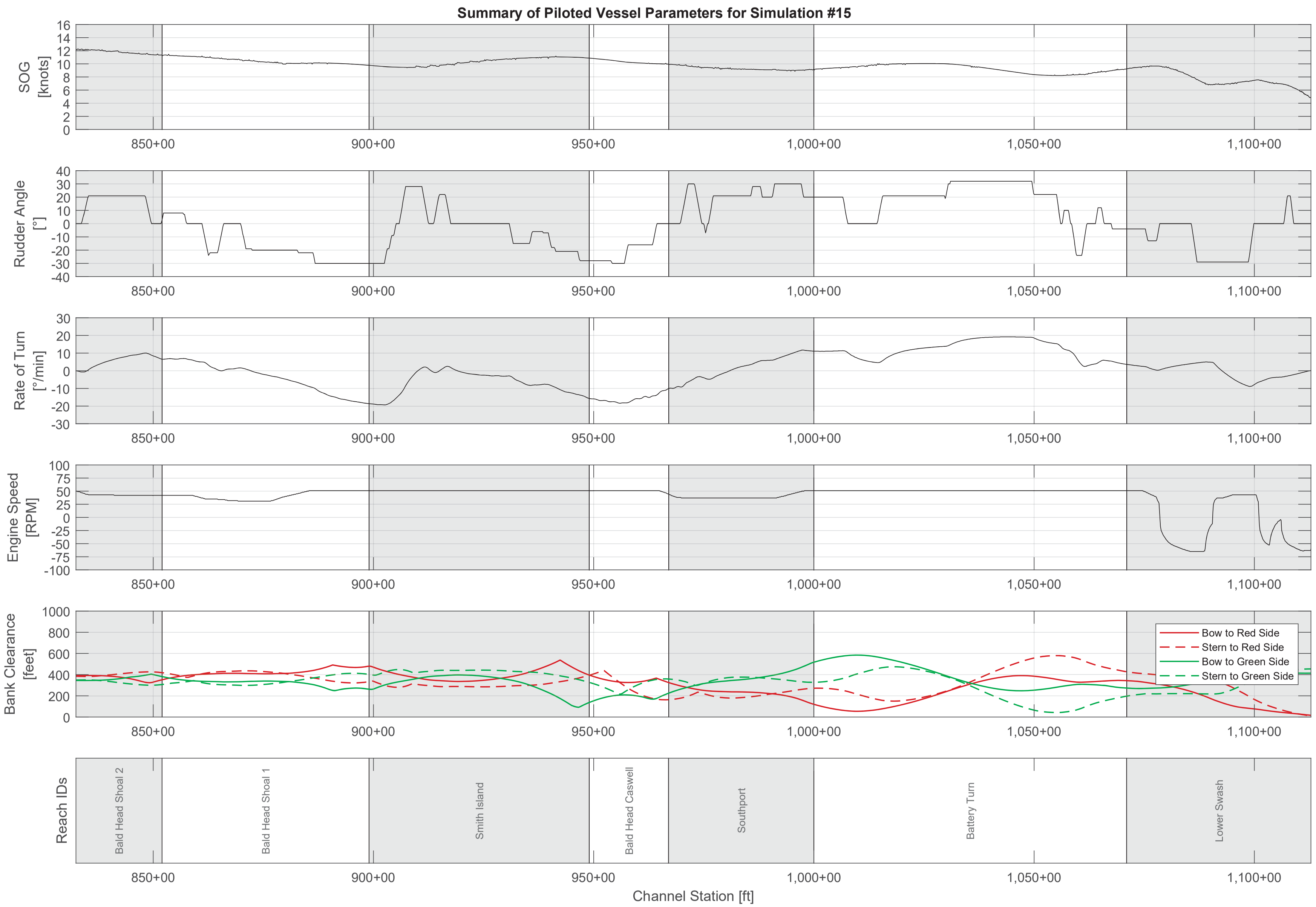


Summary of Piloted Vessel Parameters for Simulation #13



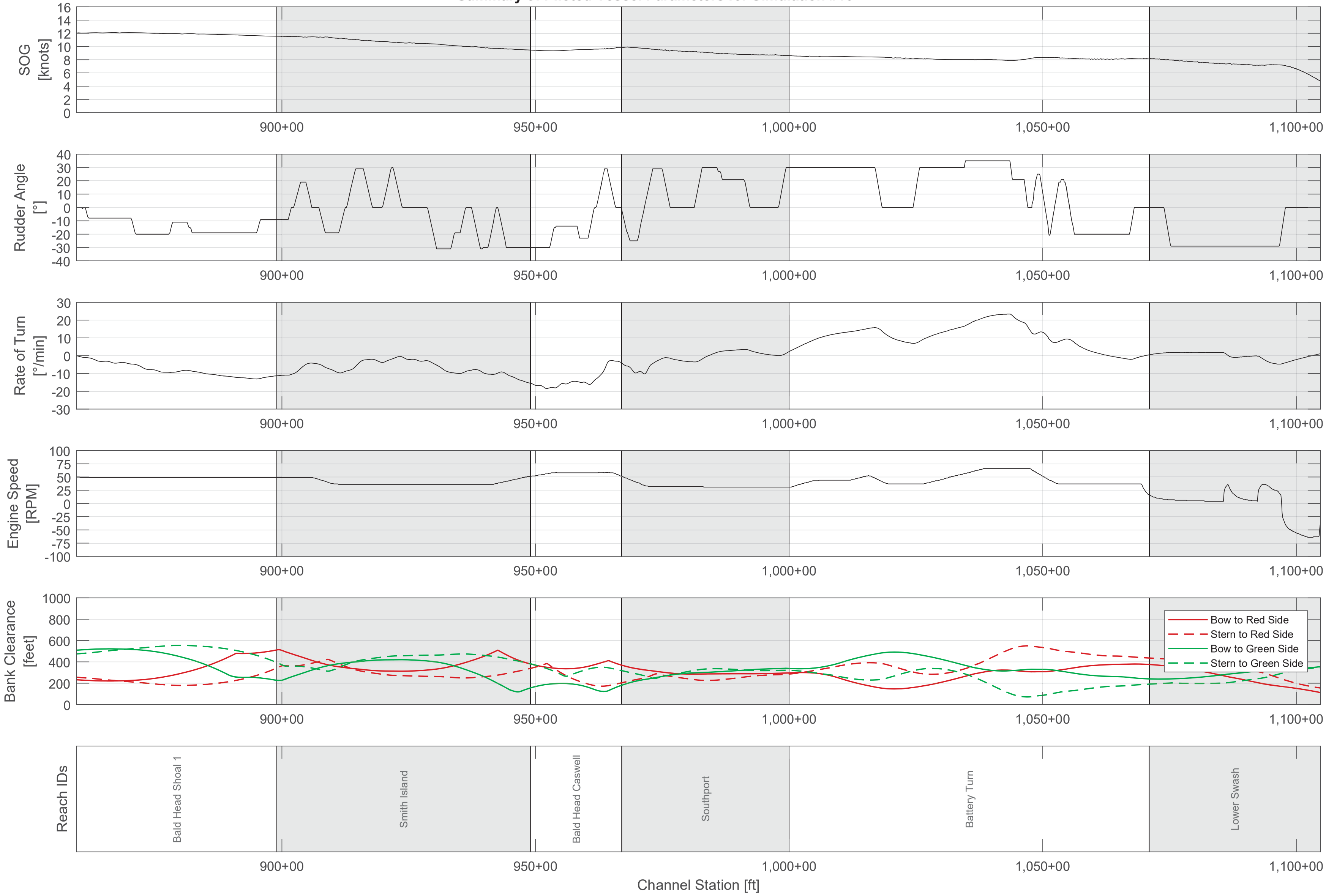
Summary of Piloted Vessel Parameters for Simulation #14



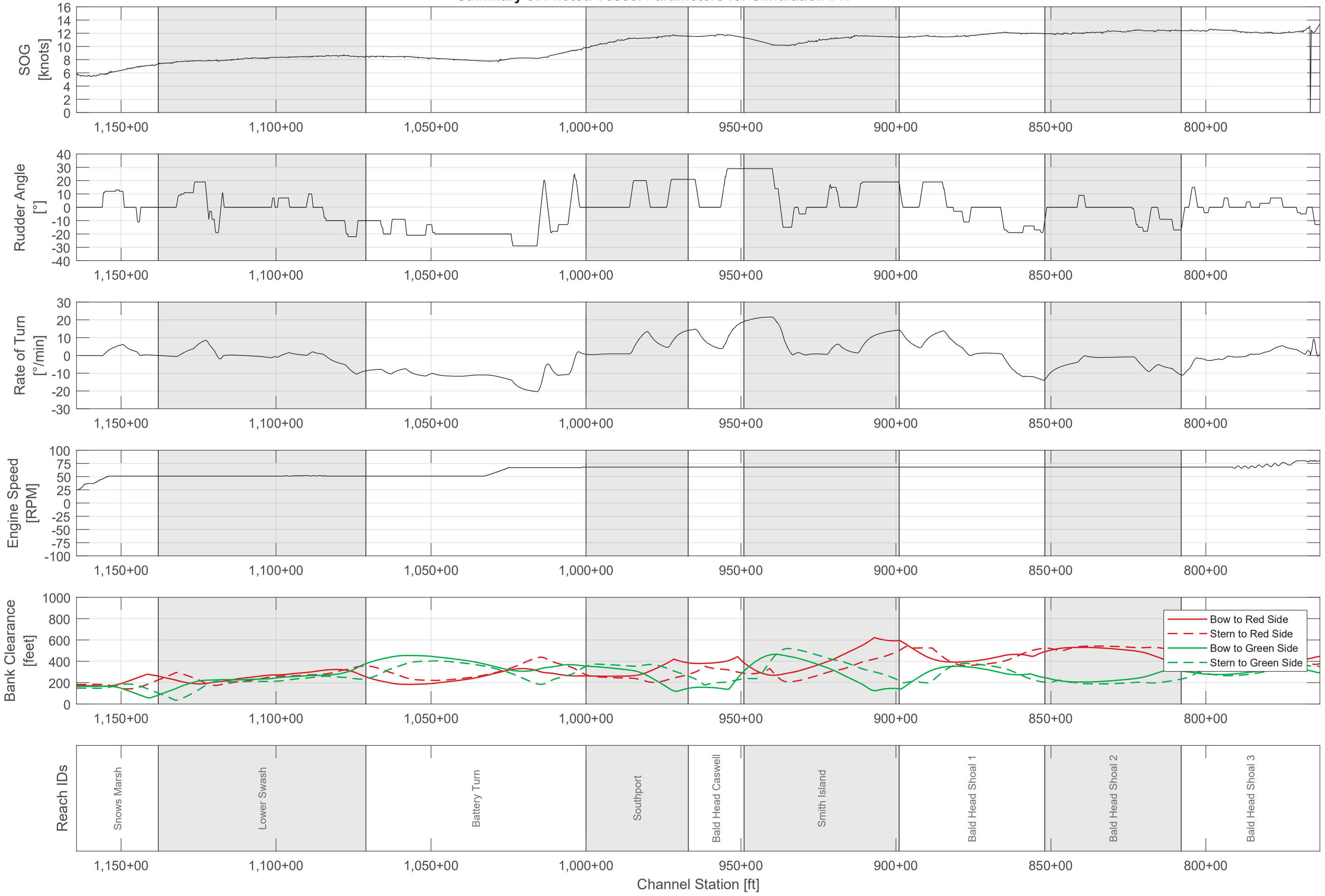


Summary of Piloted Vessel Parameters for Simulation #15

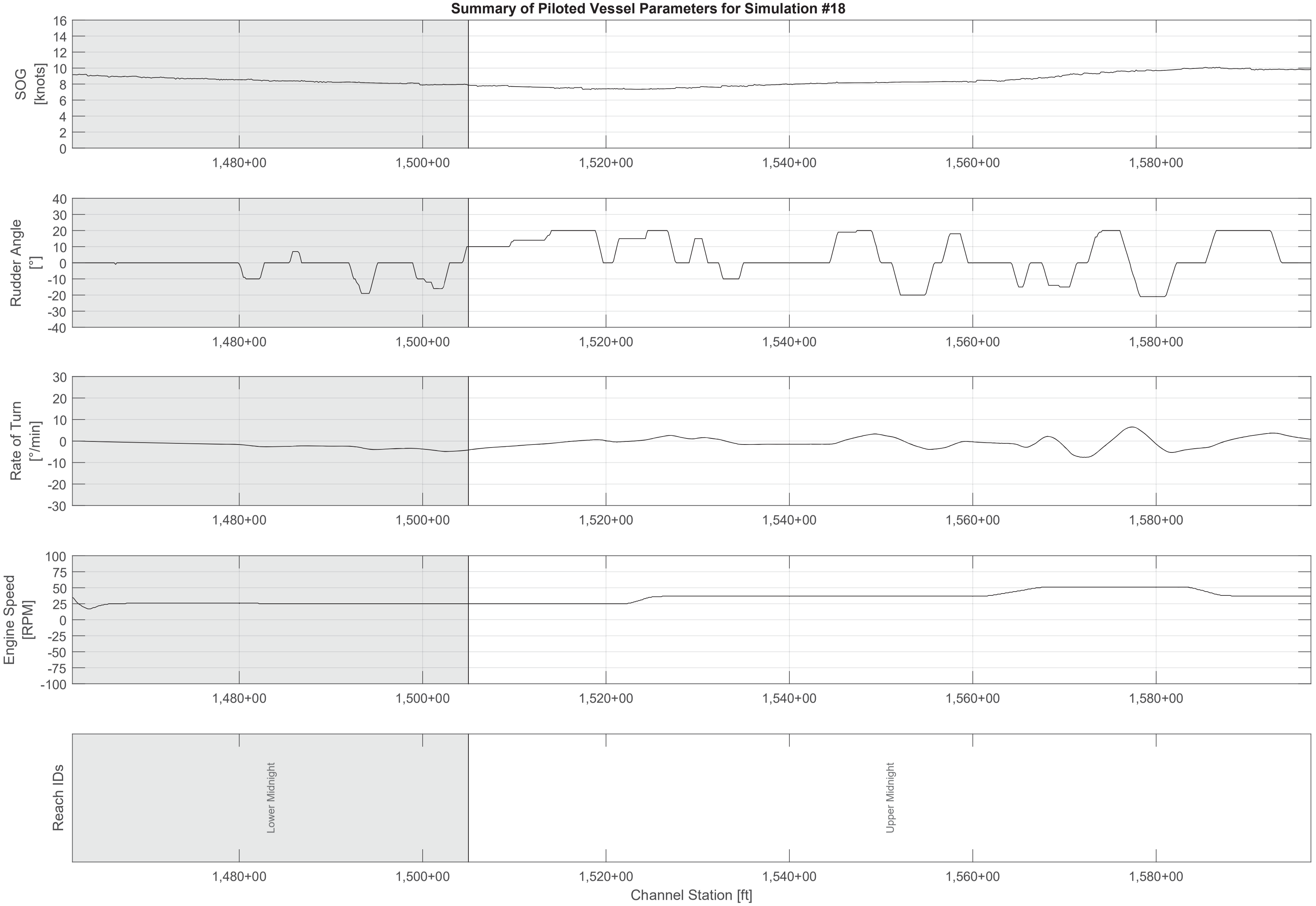
Summary of Piloted Vessel Parameters for Simulation #16



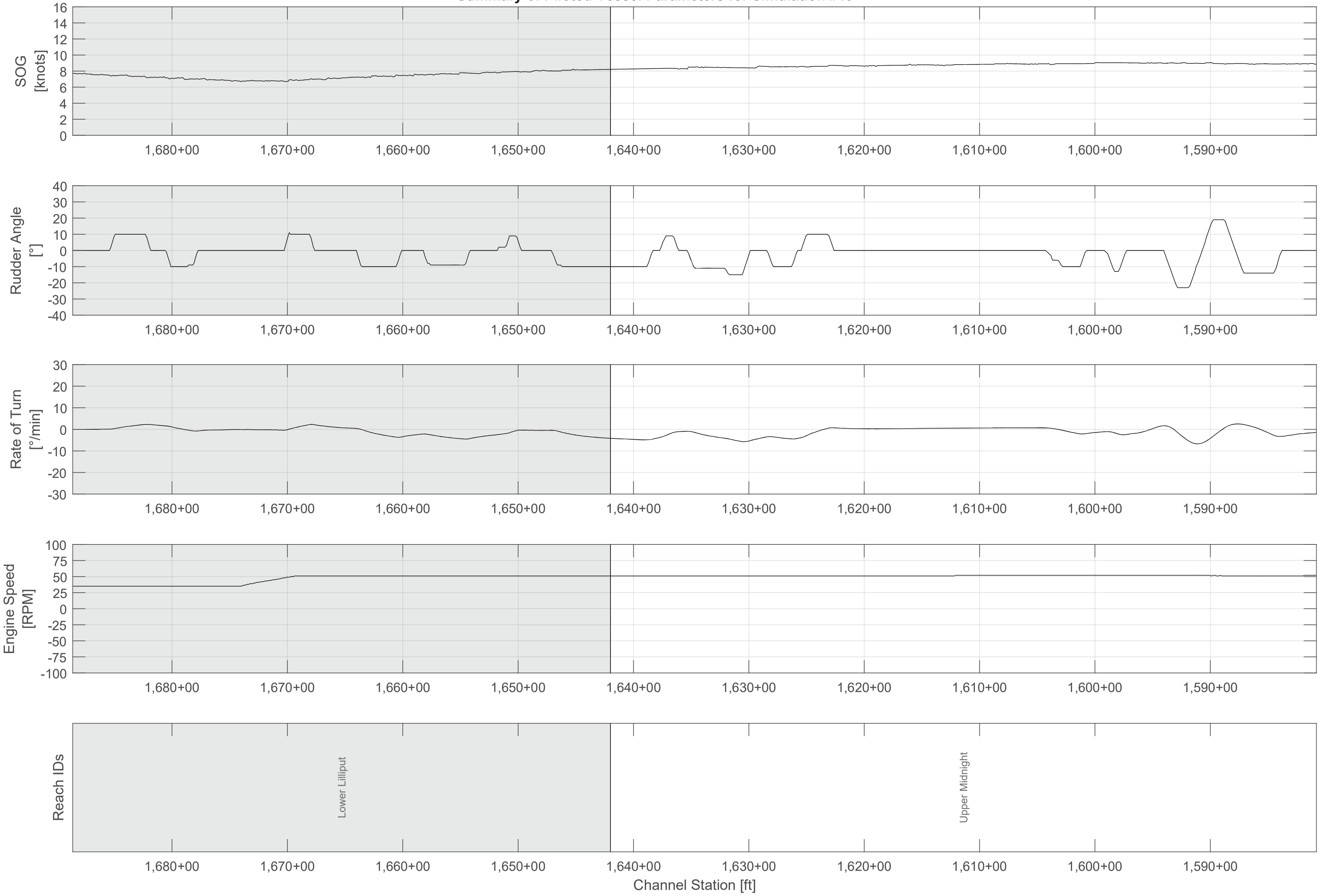
Summary of Piloted Vessel Parameters for Simulation #17



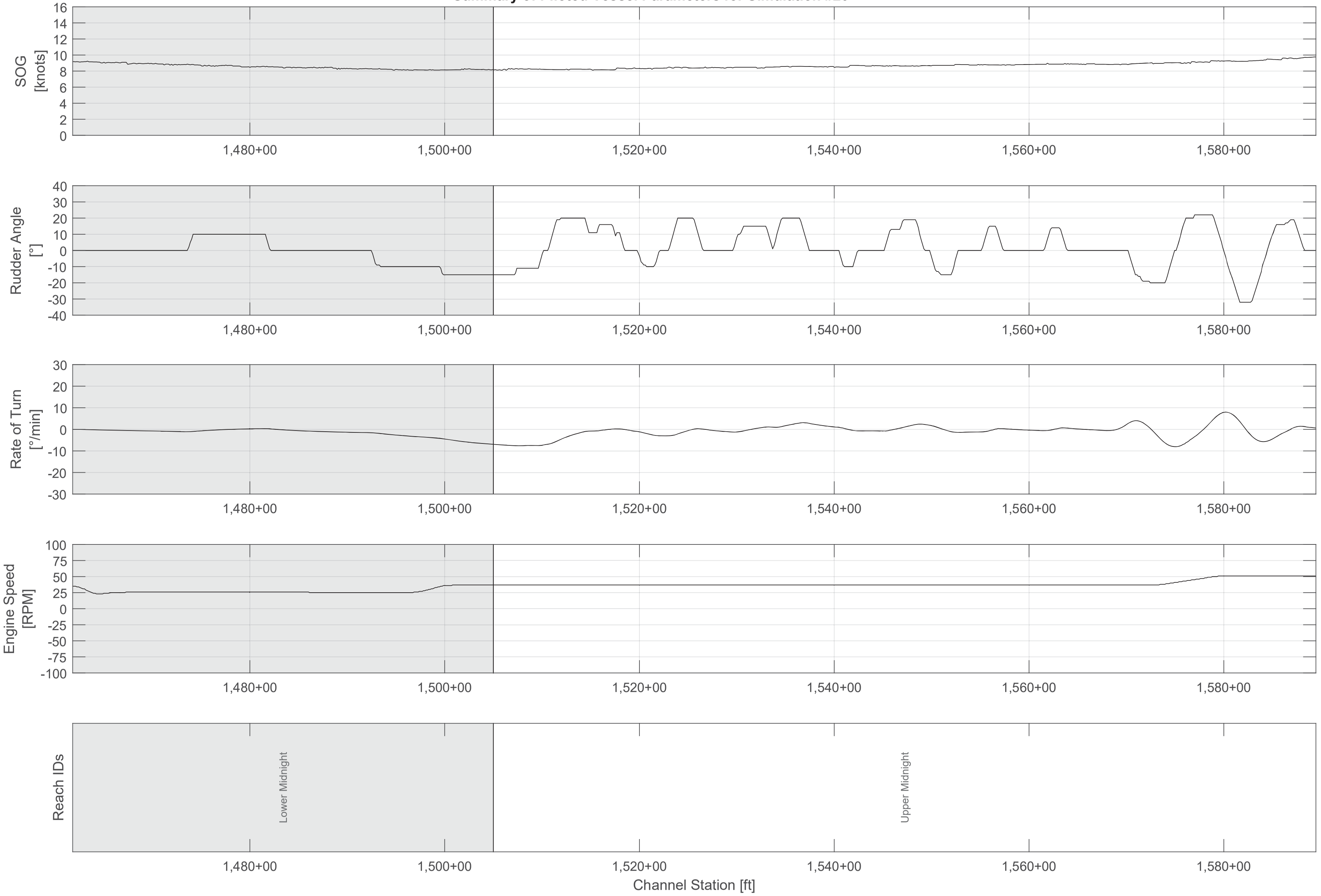
Summary of Piloted Vessel Parameters for Simulation #18



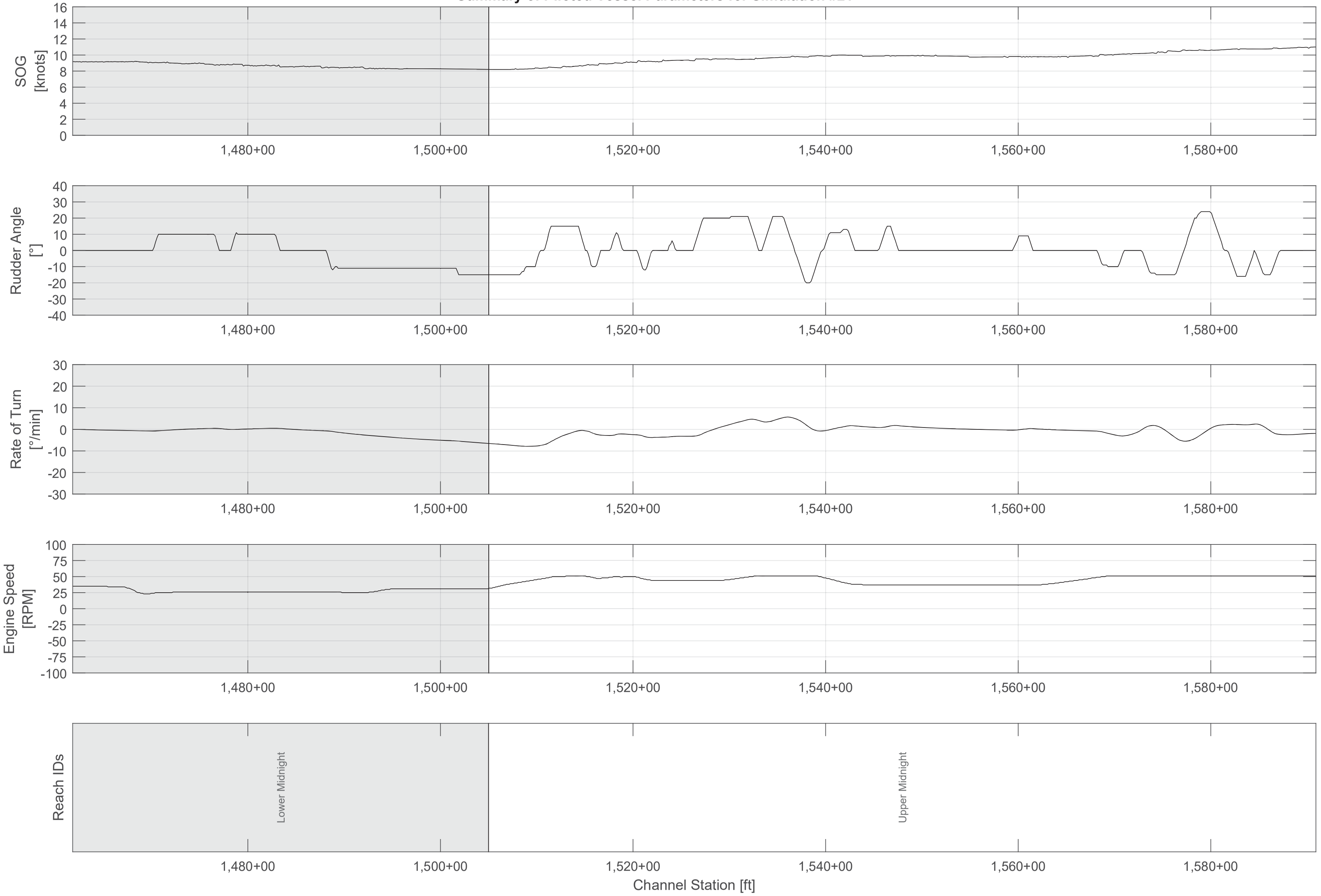
Summary of Piloted Vessel Parameters for Simulation #19



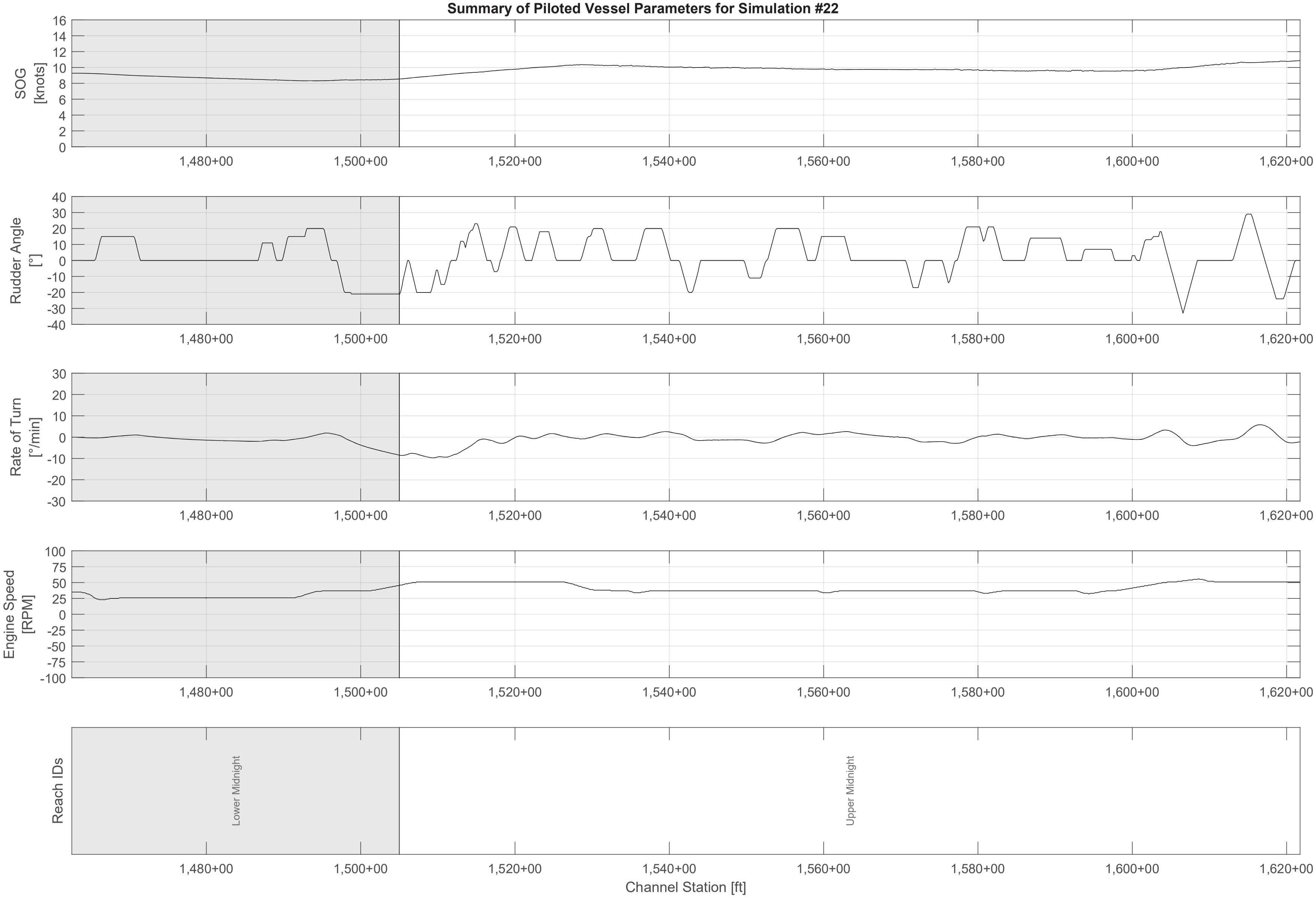
Summary of Piloted Vessel Parameters for Simulation #20



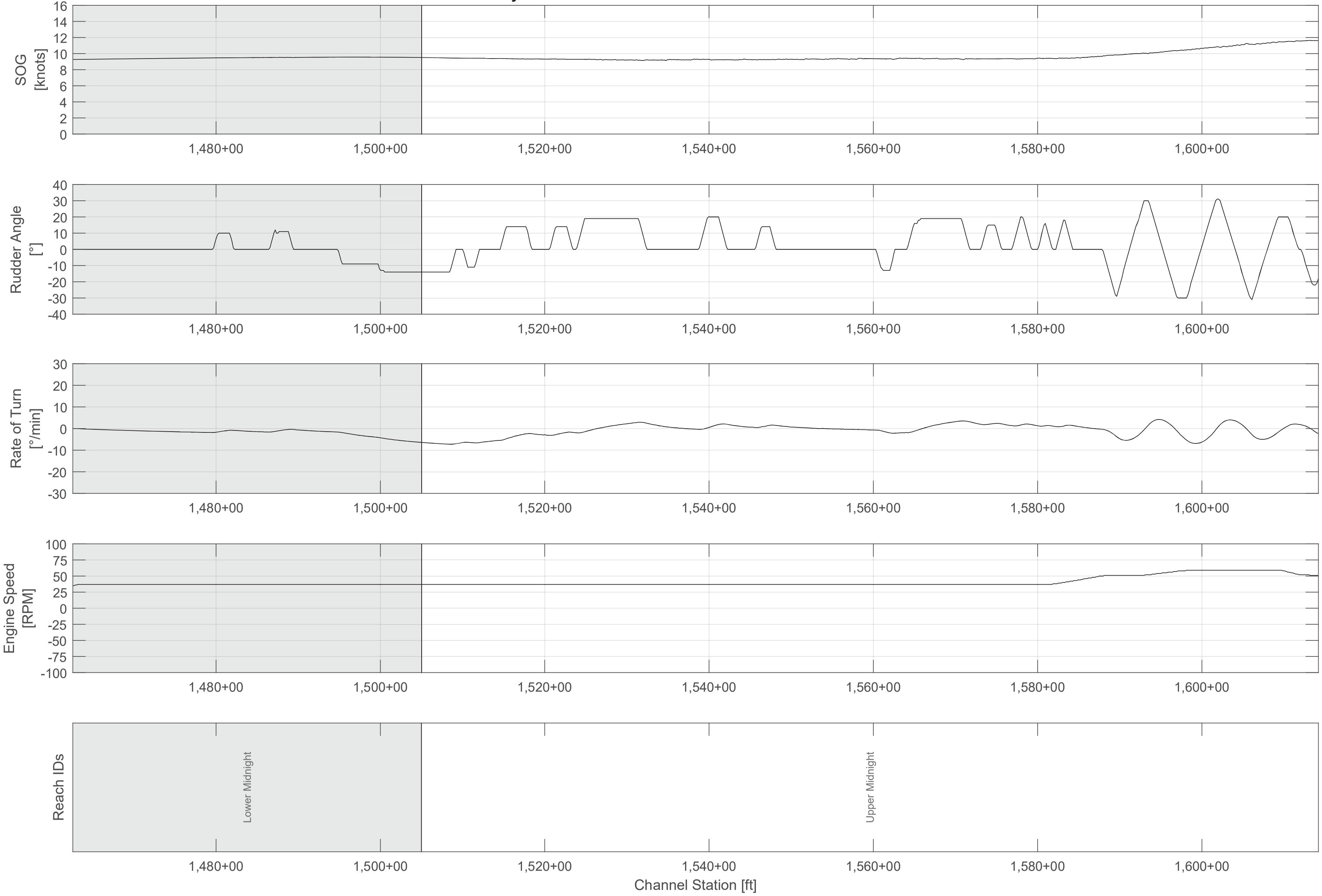
Summary of Piloted Vessel Parameters for Simulation #21

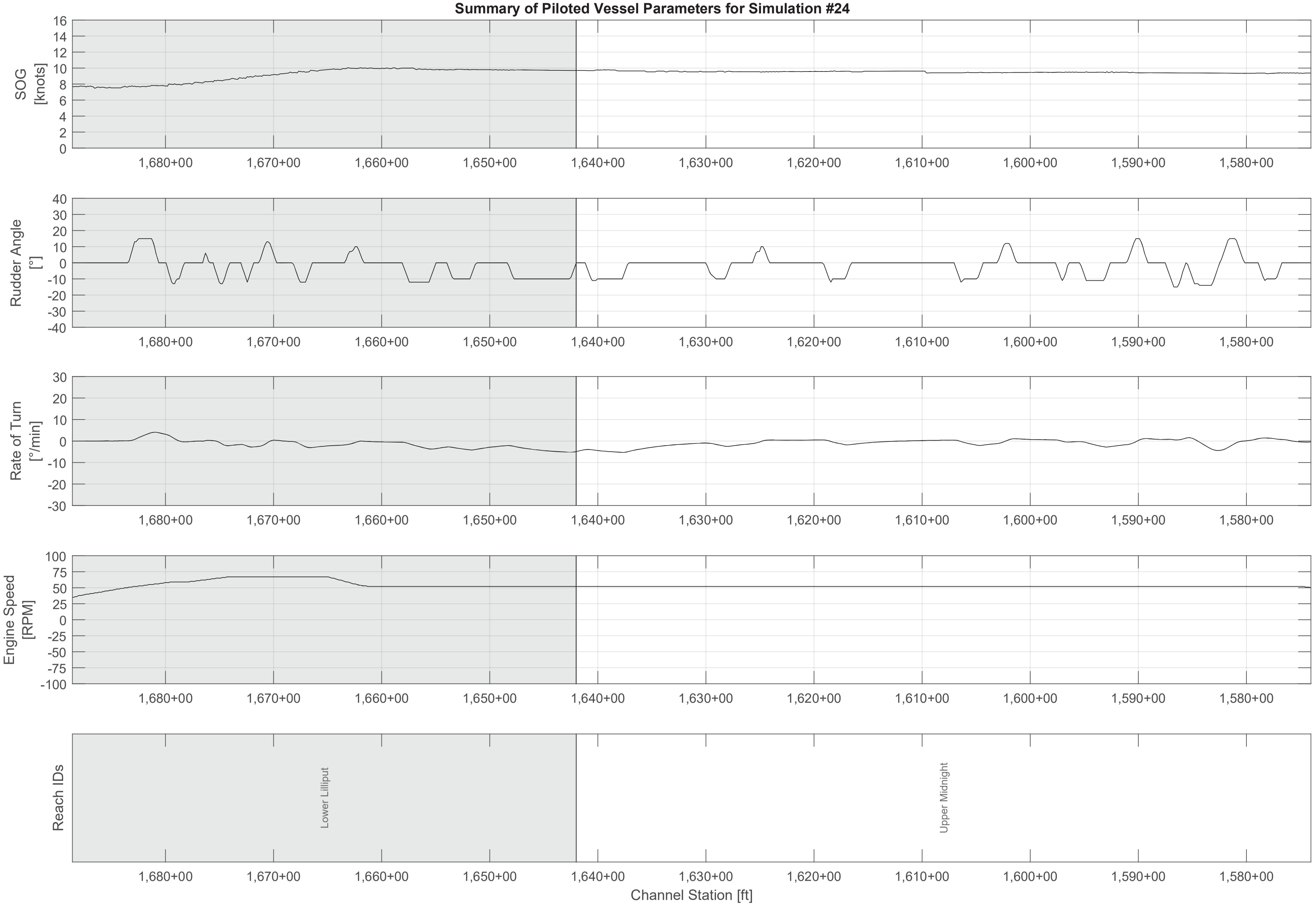


Summary of Piloted Vessel Parameters for Simulation #22



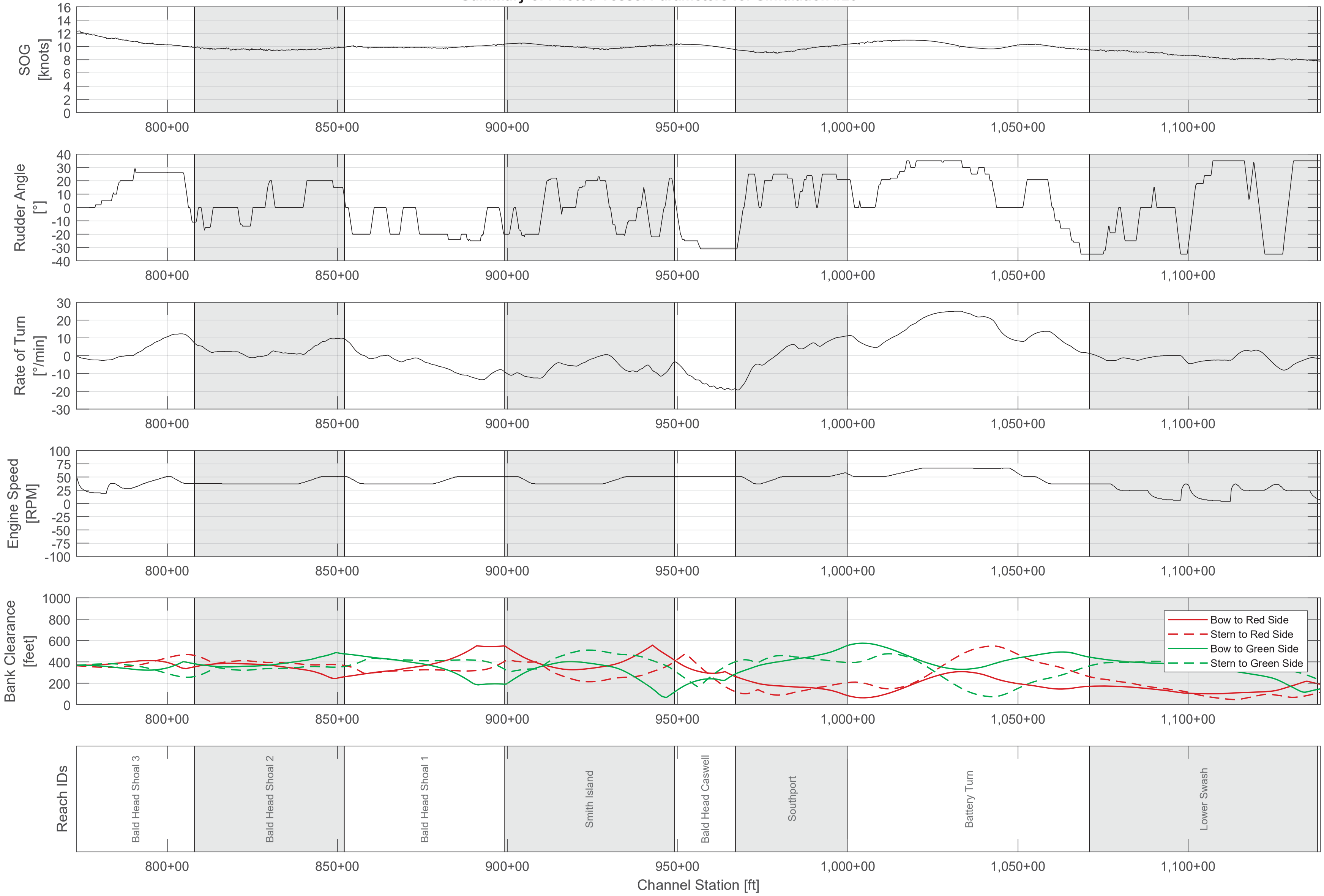
Summary of Piloted Vessel Parameters for Simulation #23



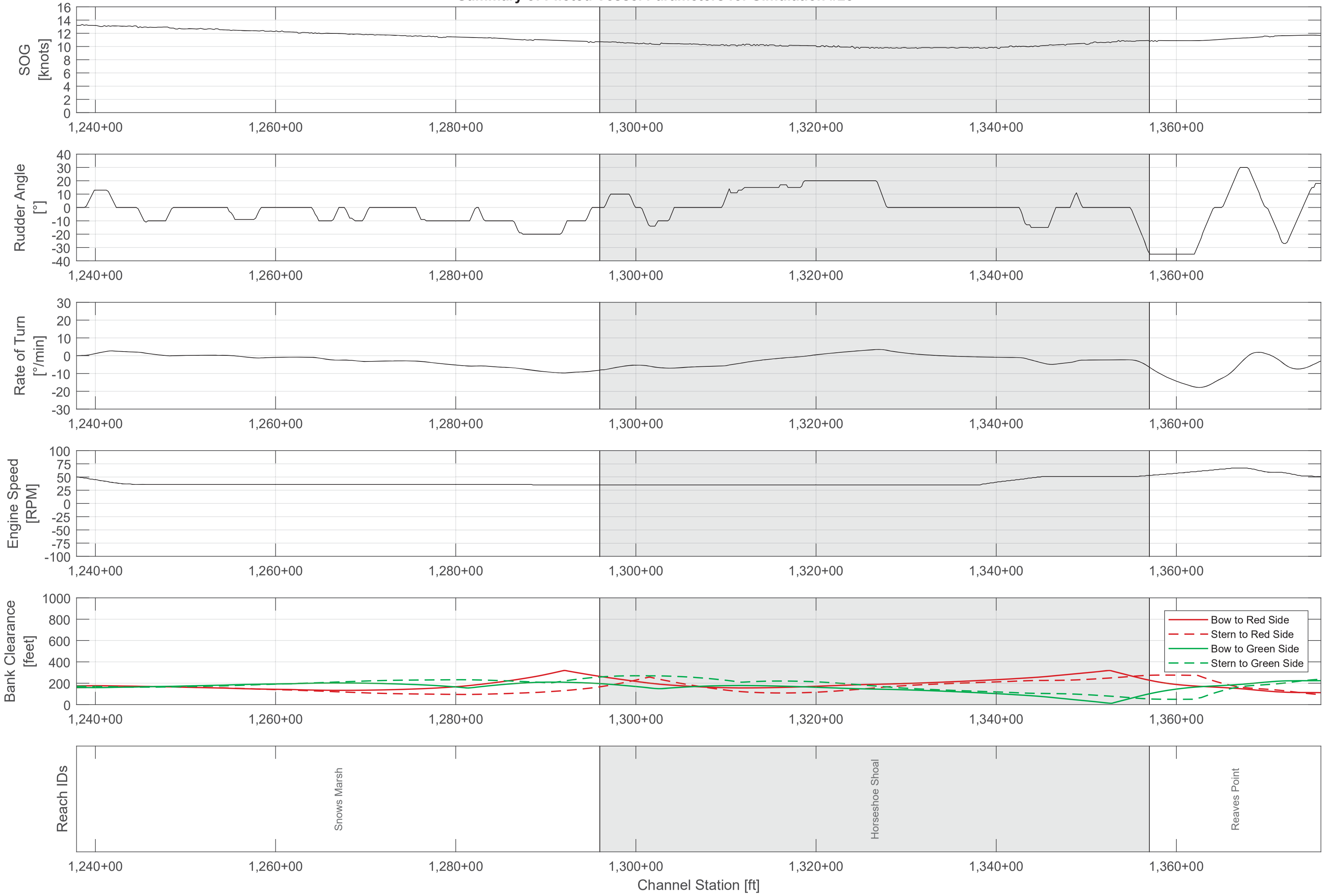


Summary of Piloted Vessel Parameters for Simulation #24

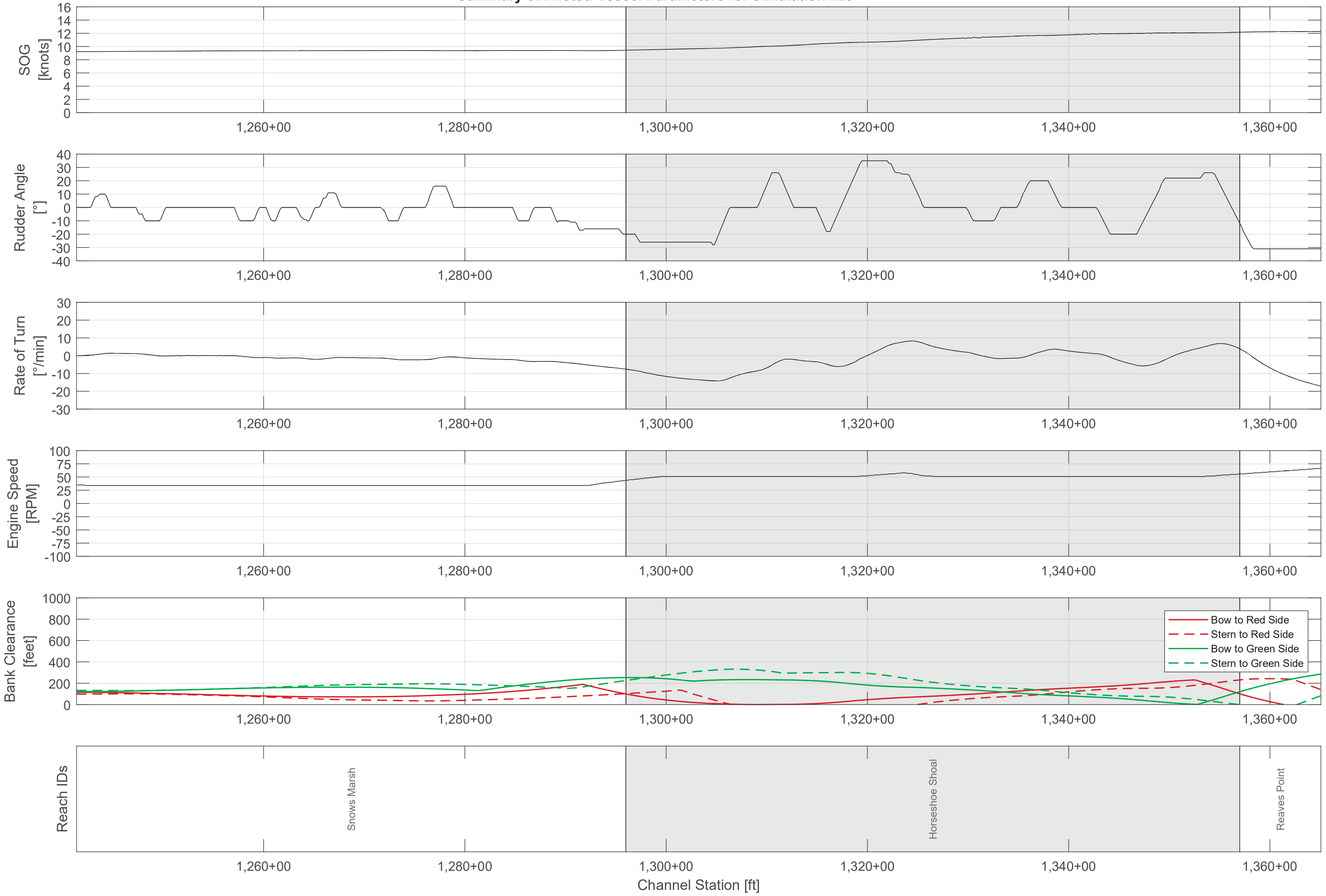
Summary of Piloted Vessel Parameters for Simulation #26



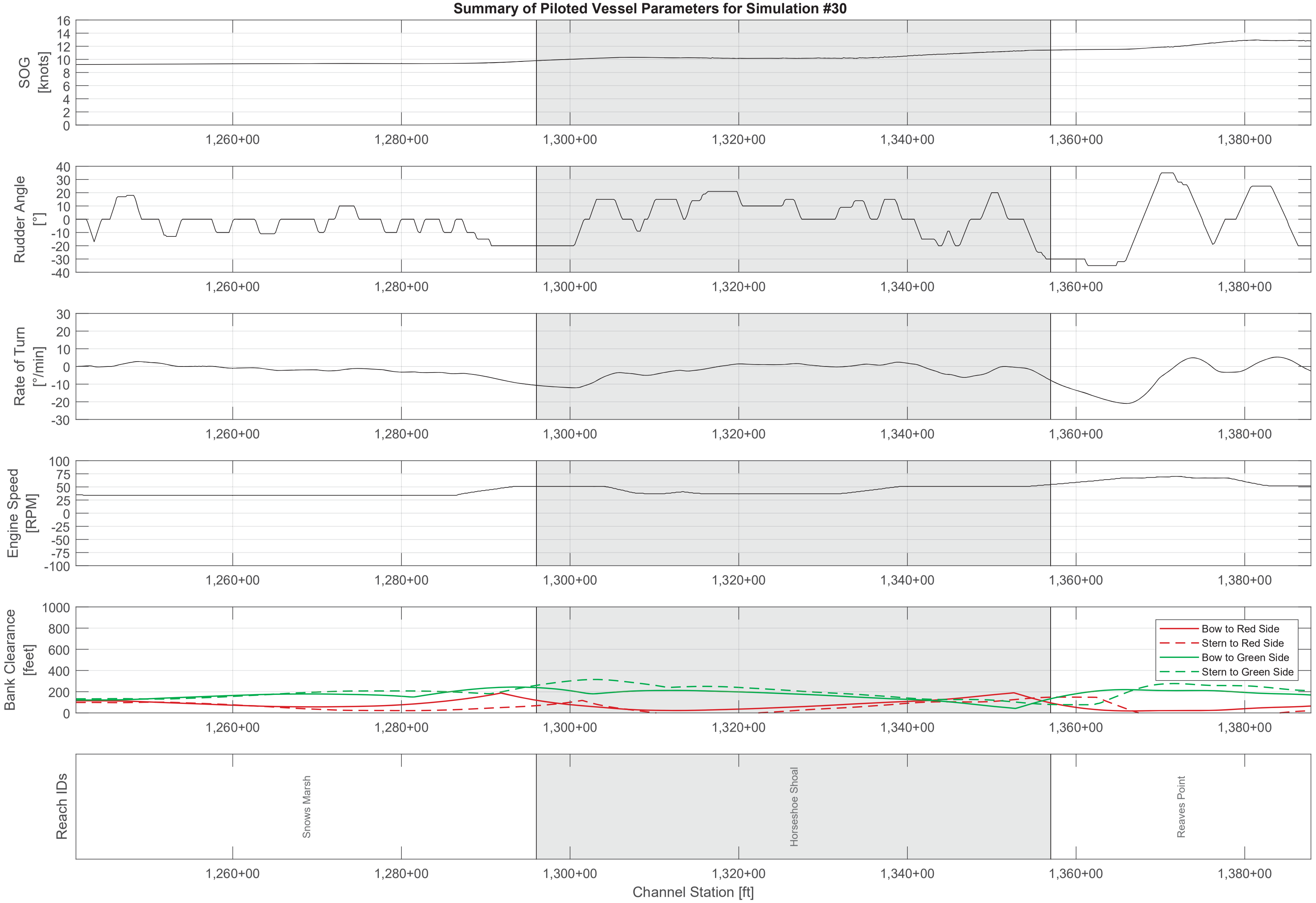
Summary of Piloted Vessel Parameters for Simulation #28



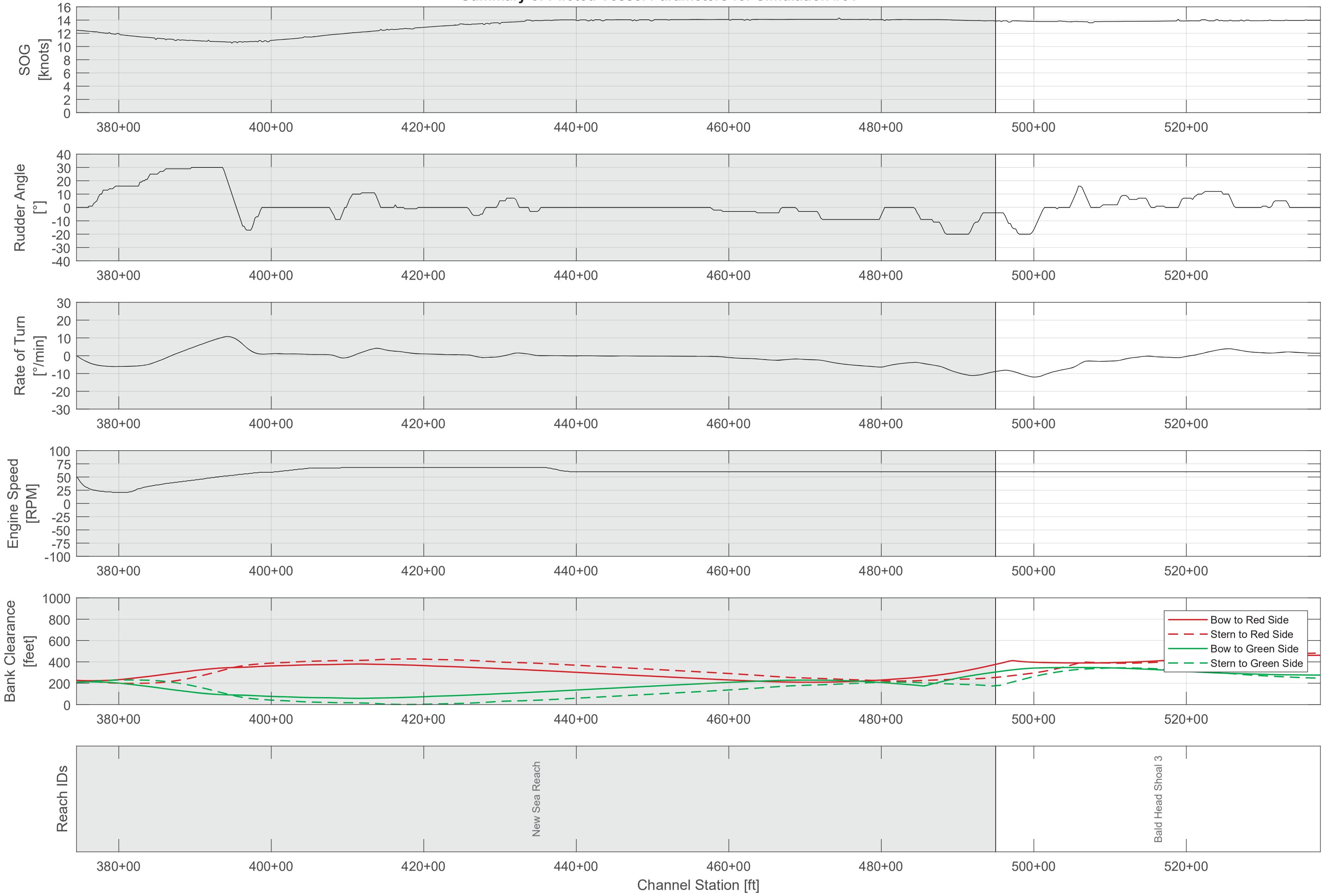
Summary of Piloted Vessel Parameters for Simulation #29



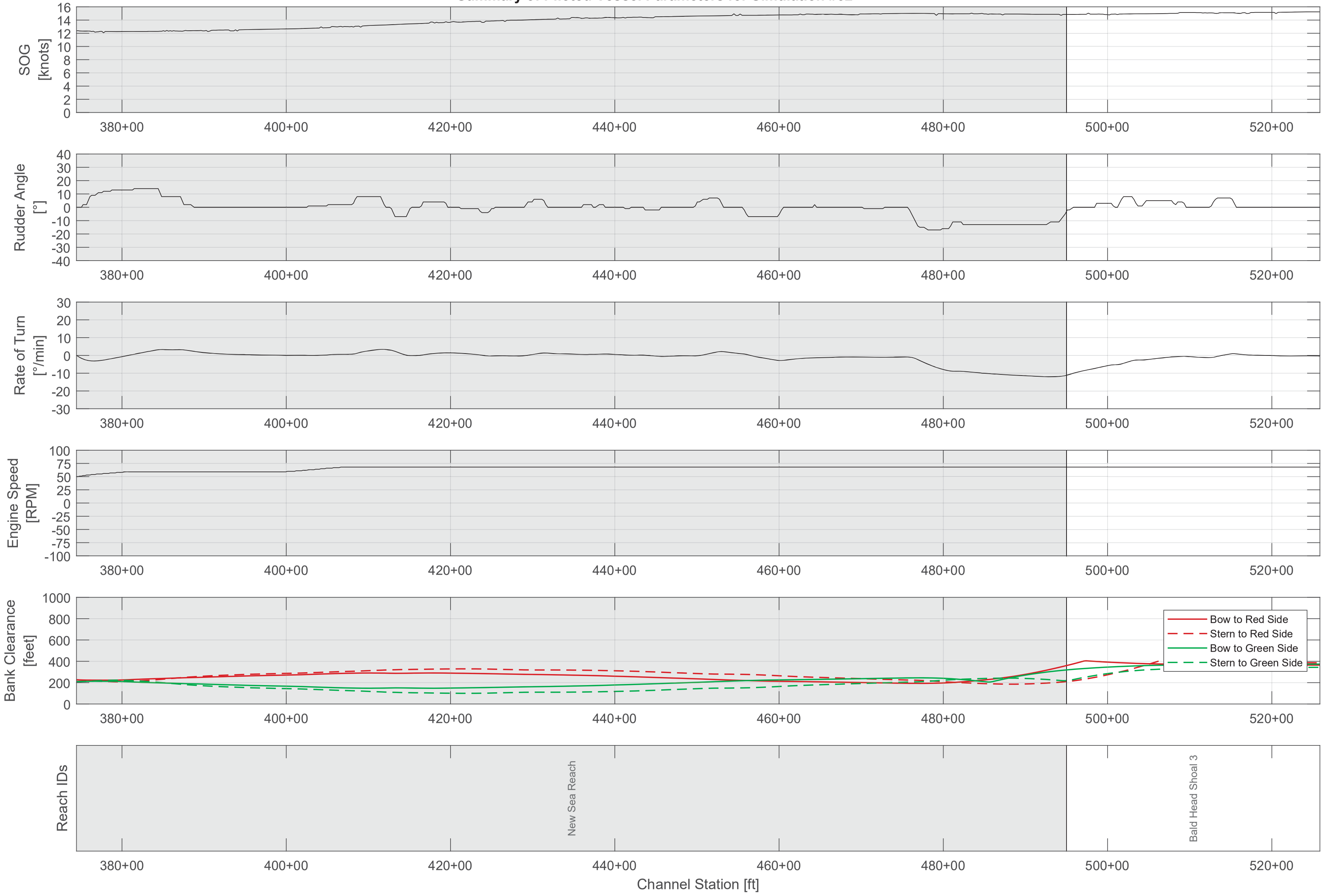
Summary of Piloted Vessel Parameters for Simulation #30

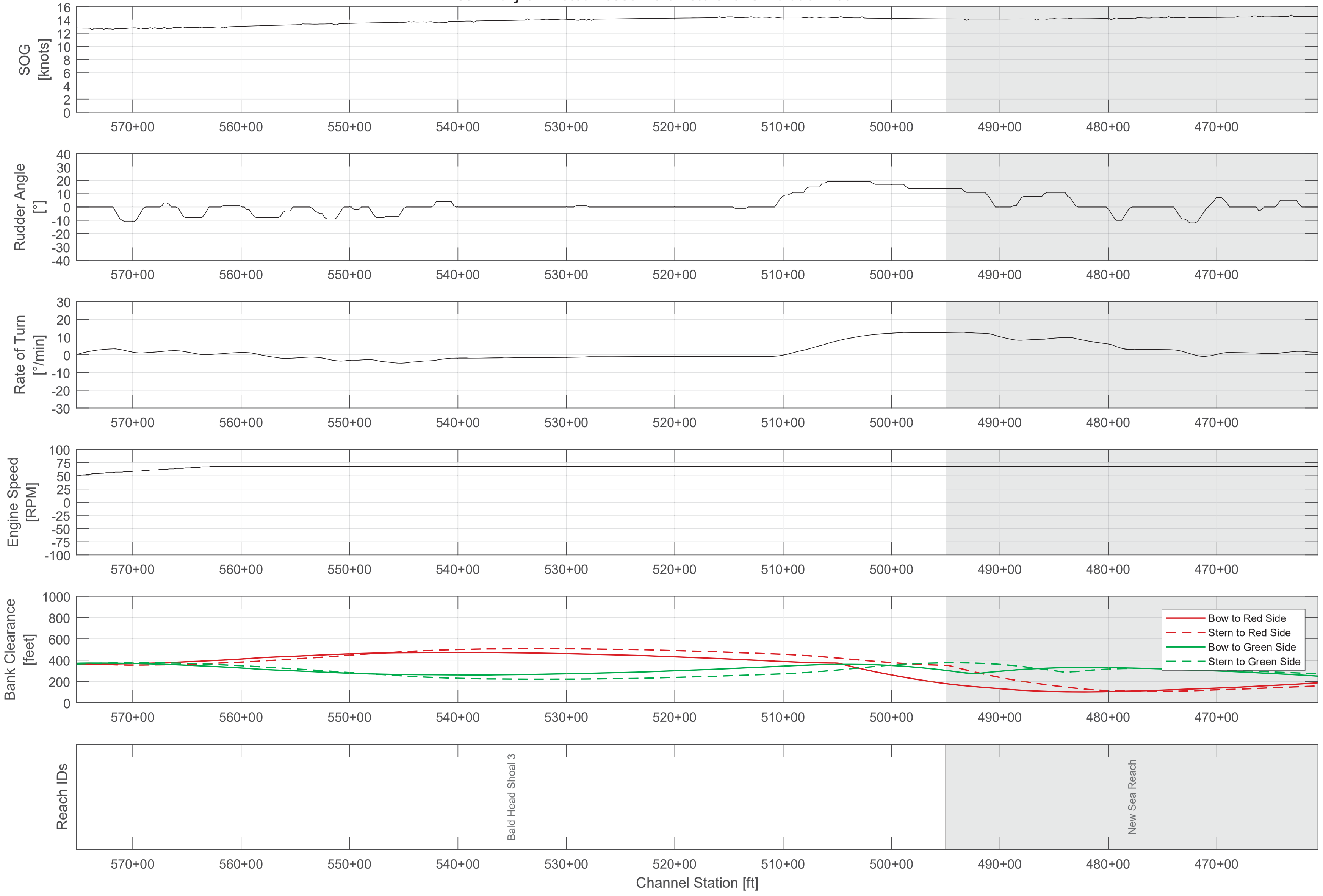


Summary of Piloted Vessel Parameters for Simulation #31



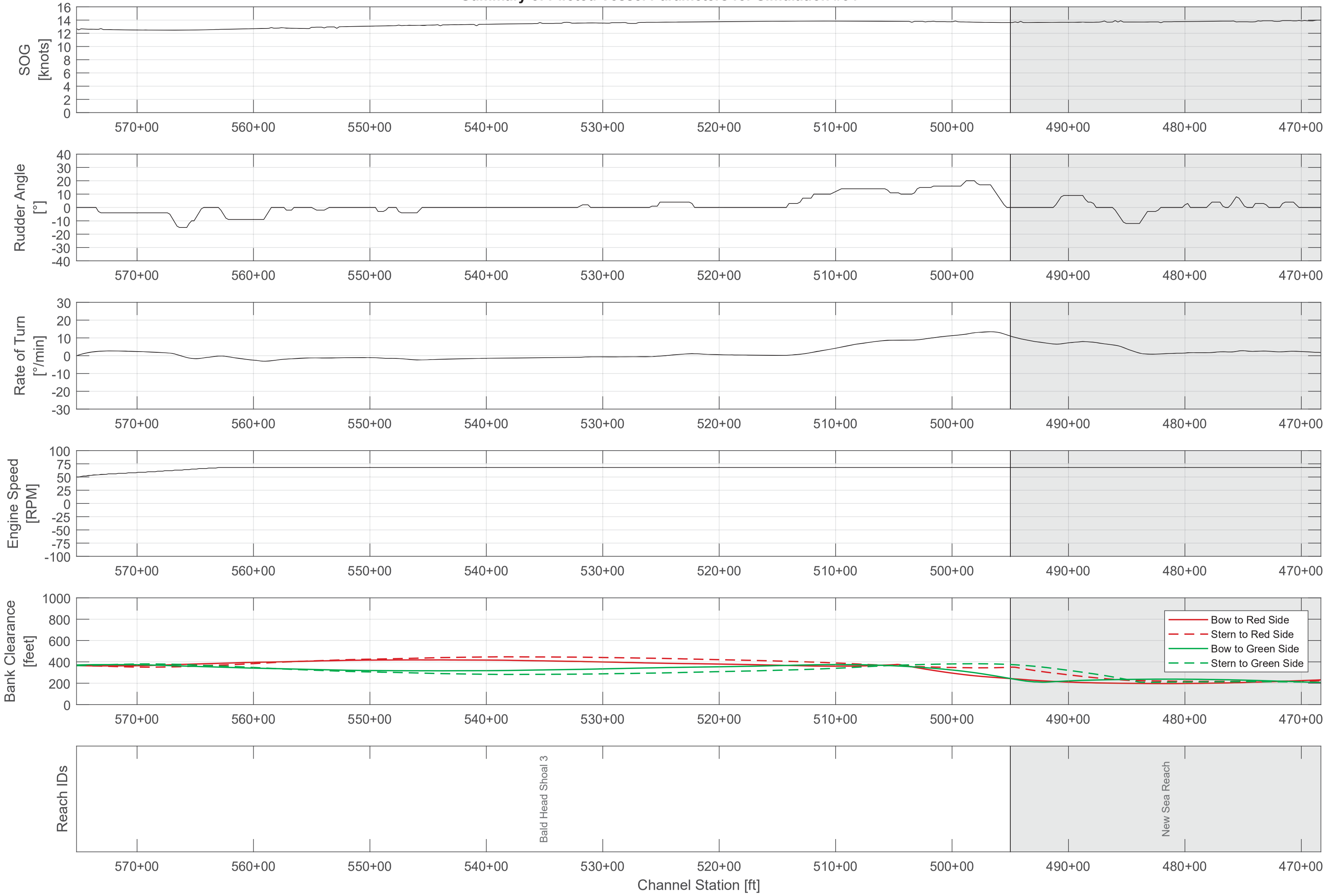
Summary of Piloted Vessel Parameters for Simulation #32



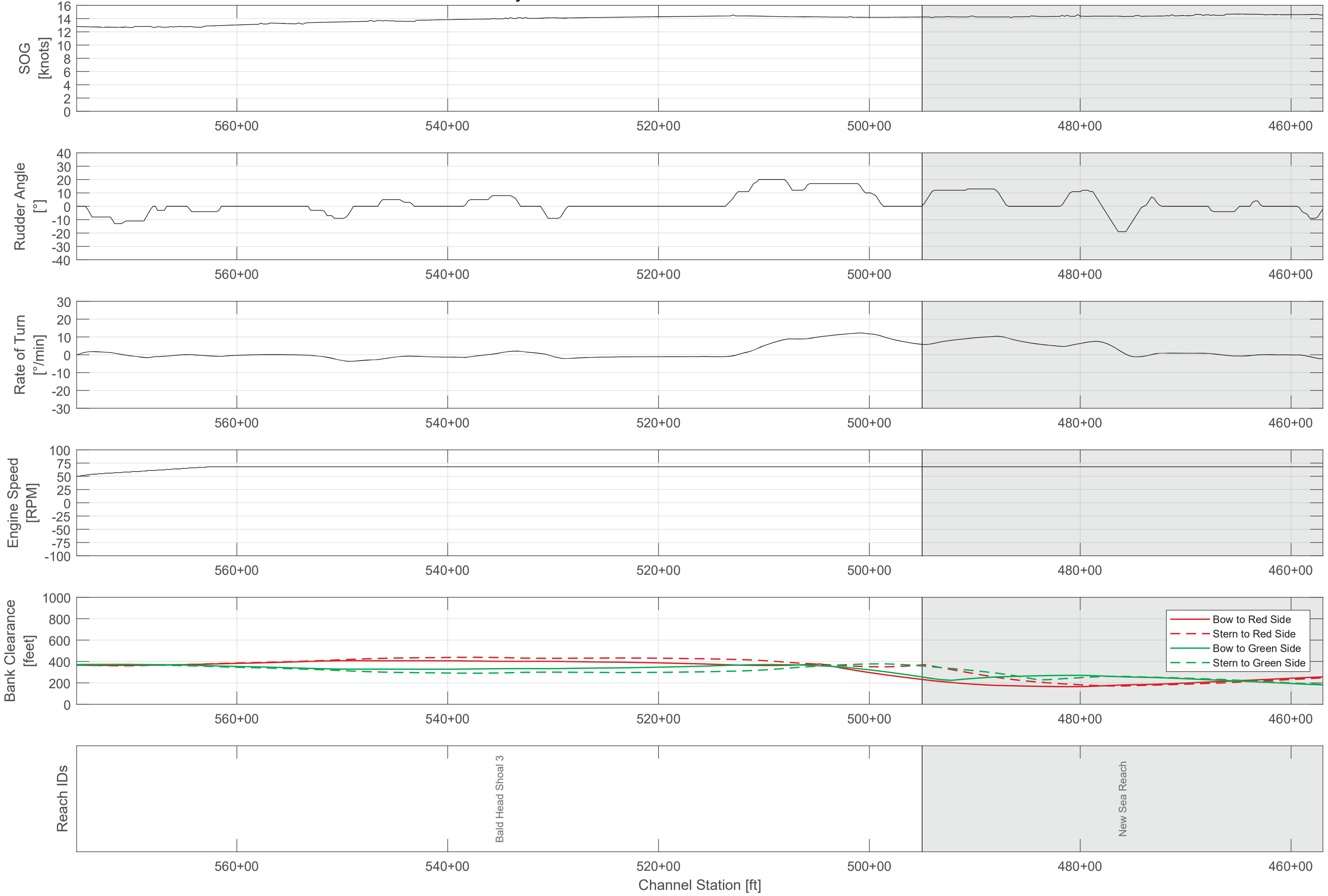


Summary of Piloted Vessel Parameters for Simulation #33

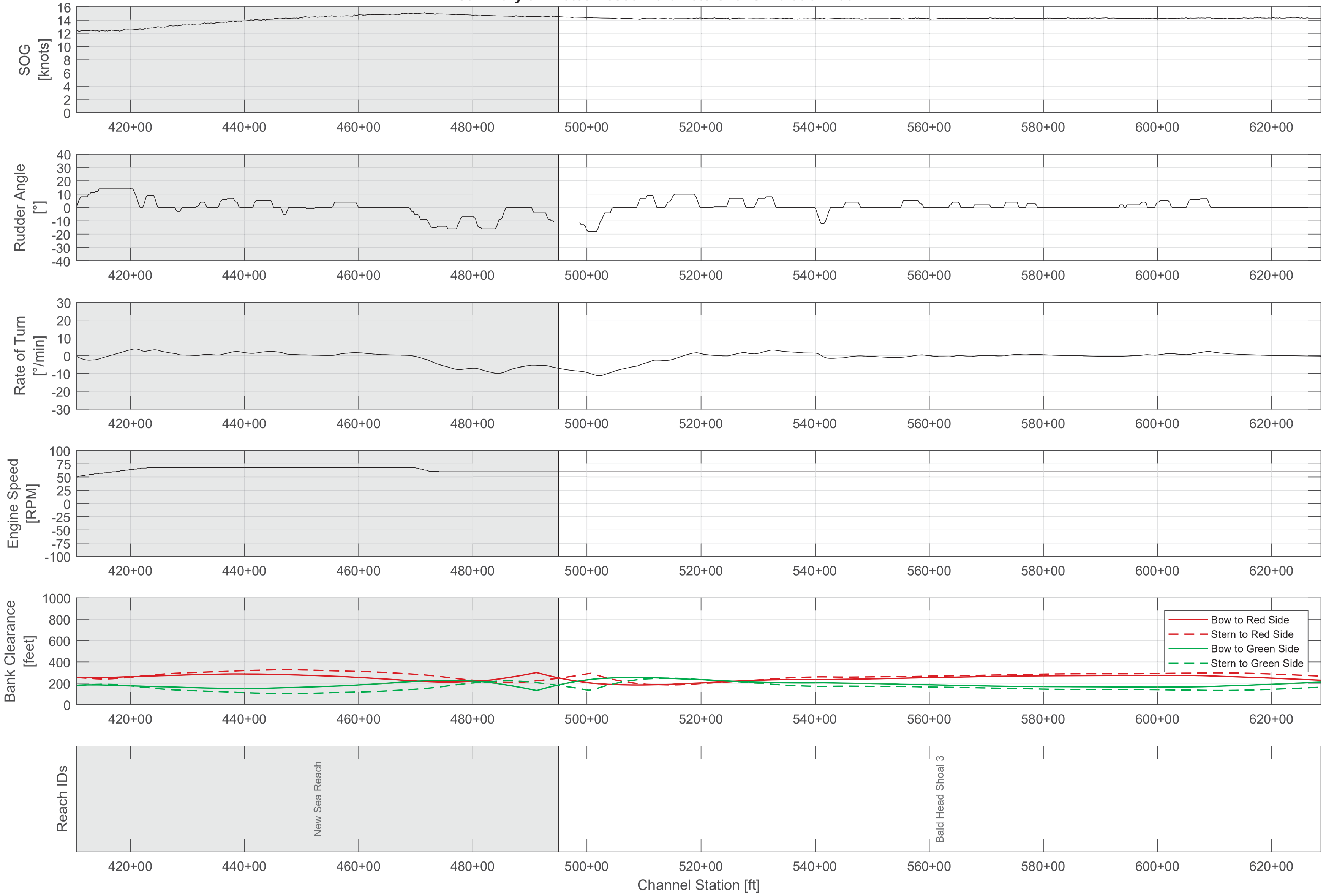
Summary of Piloted Vessel Parameters for Simulation #34



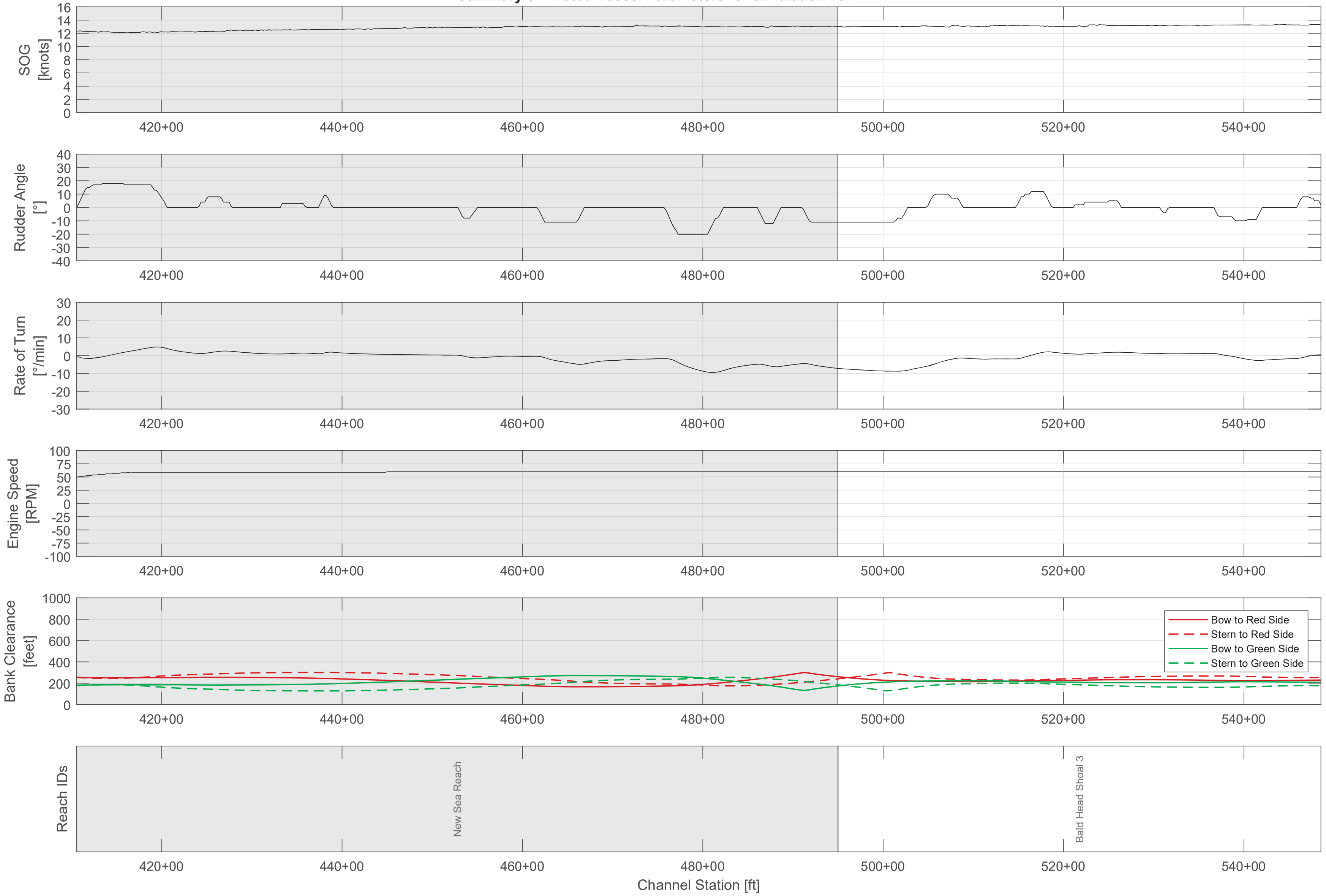
Summary of Piloted Vessel Parameters for Simulation #35



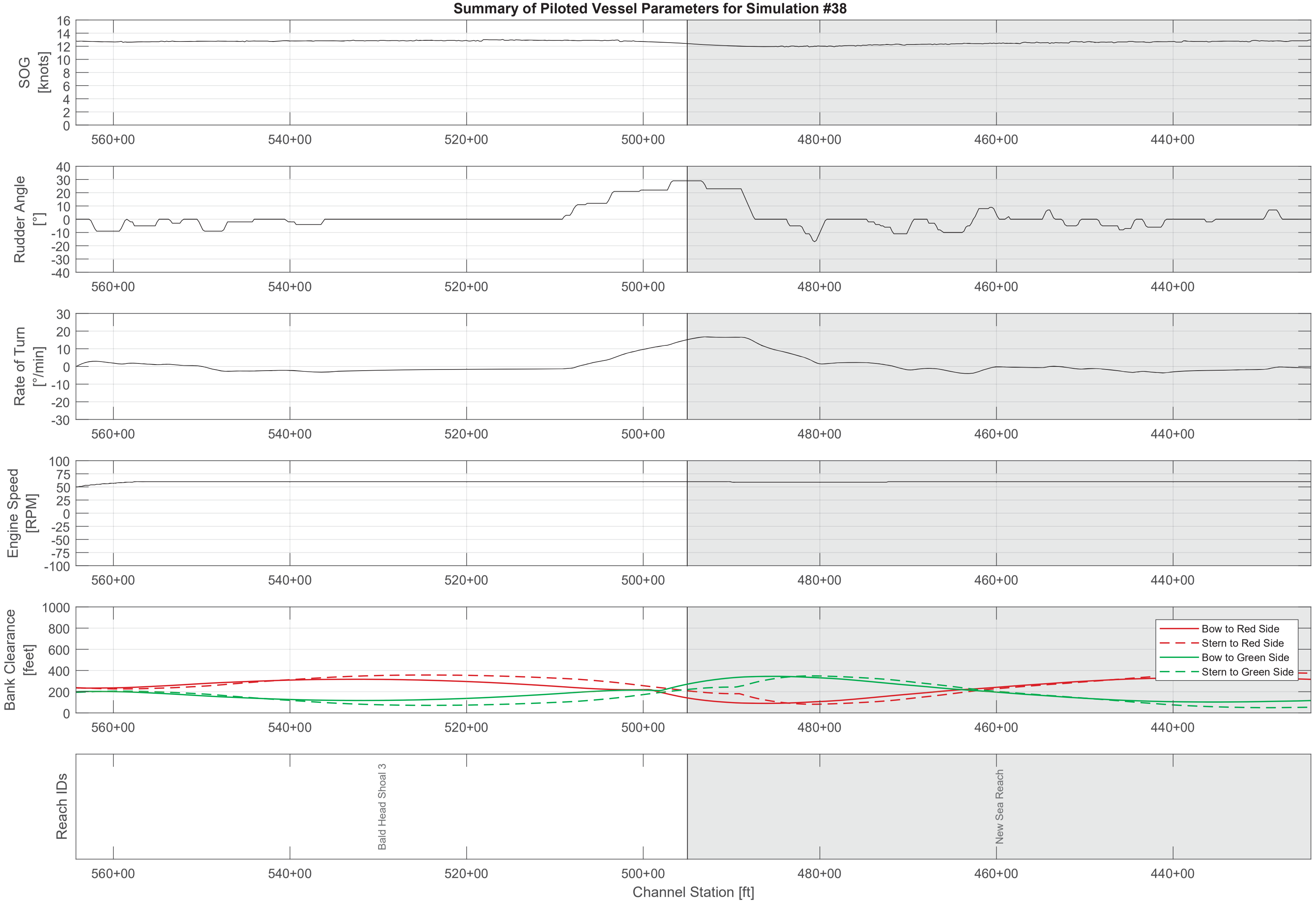
Summary of Piloted Vessel Parameters for Simulation #36



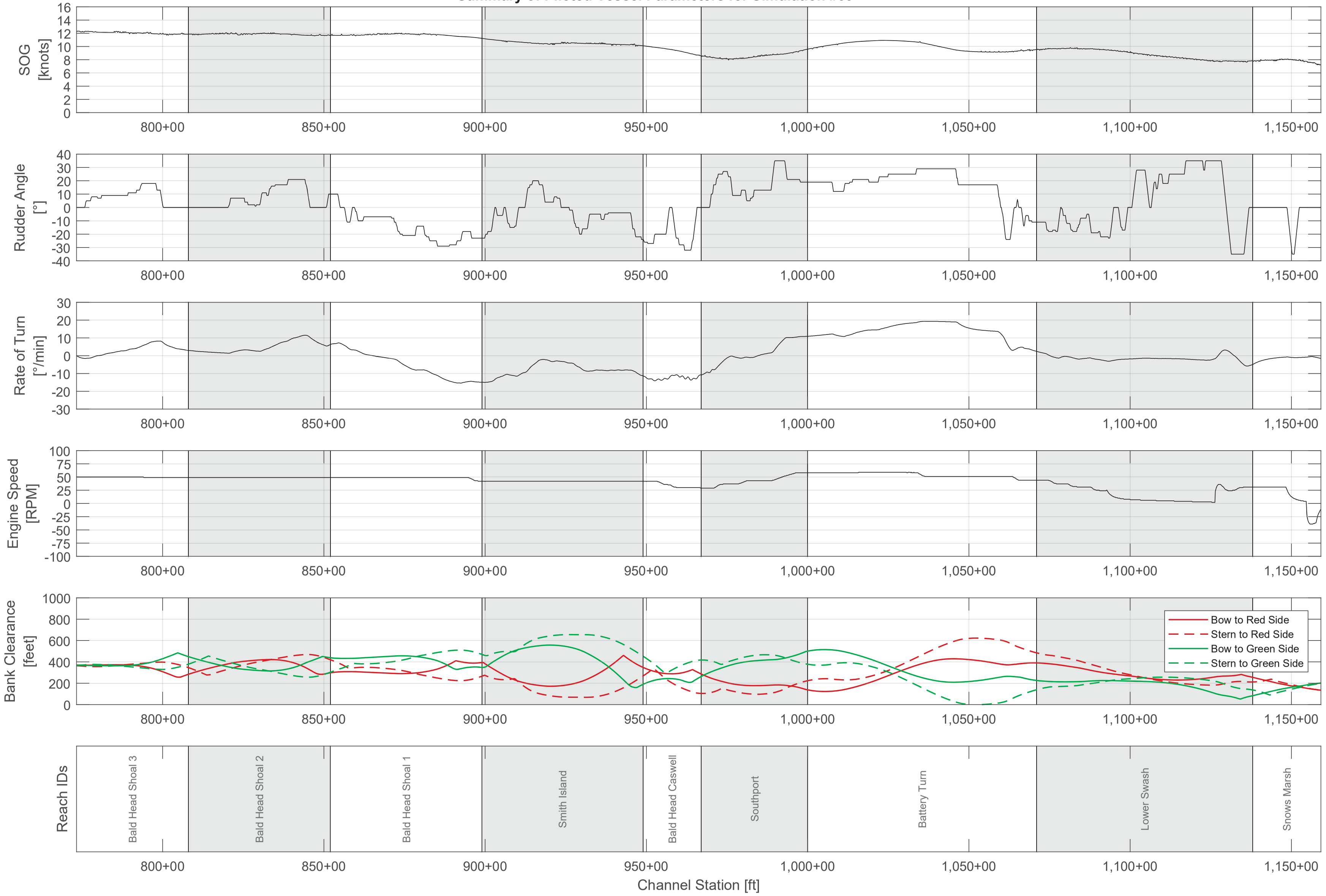
Summary of Piloted Vessel Parameters for Simulation #37



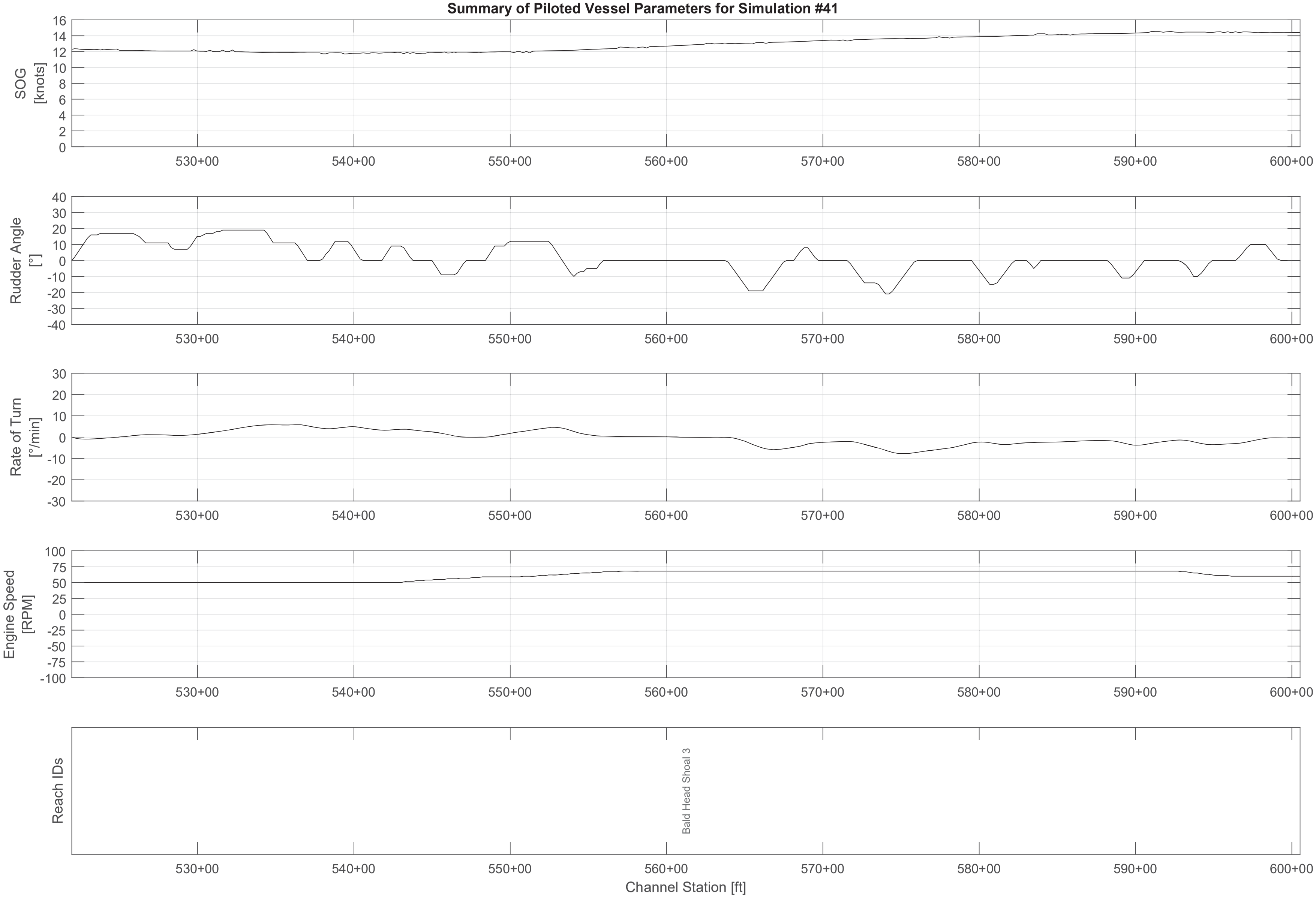
Summary of Piloted Vessel Parameters for Simulation #38



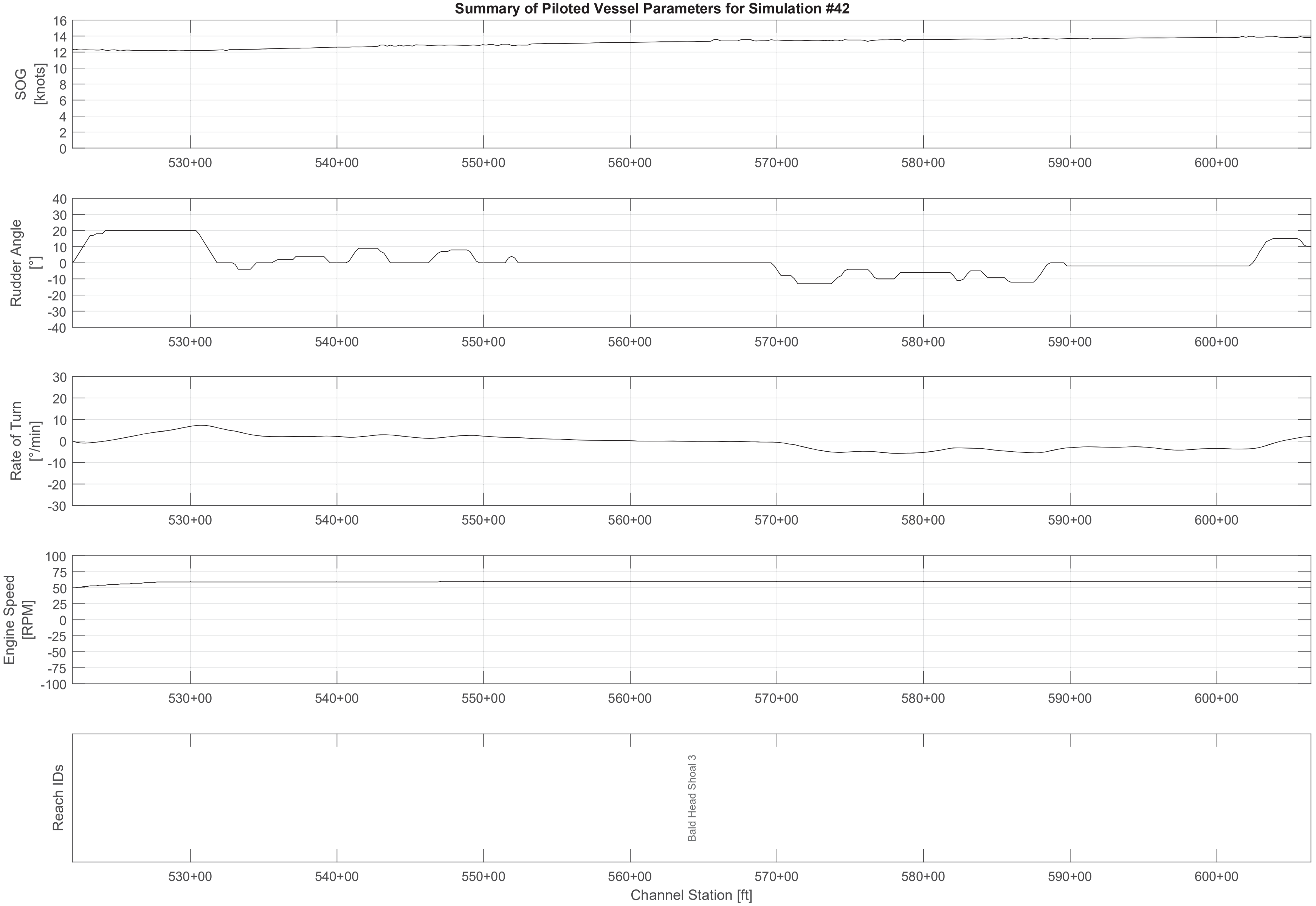
Summary of Piloted Vessel Parameters for Simulation #39



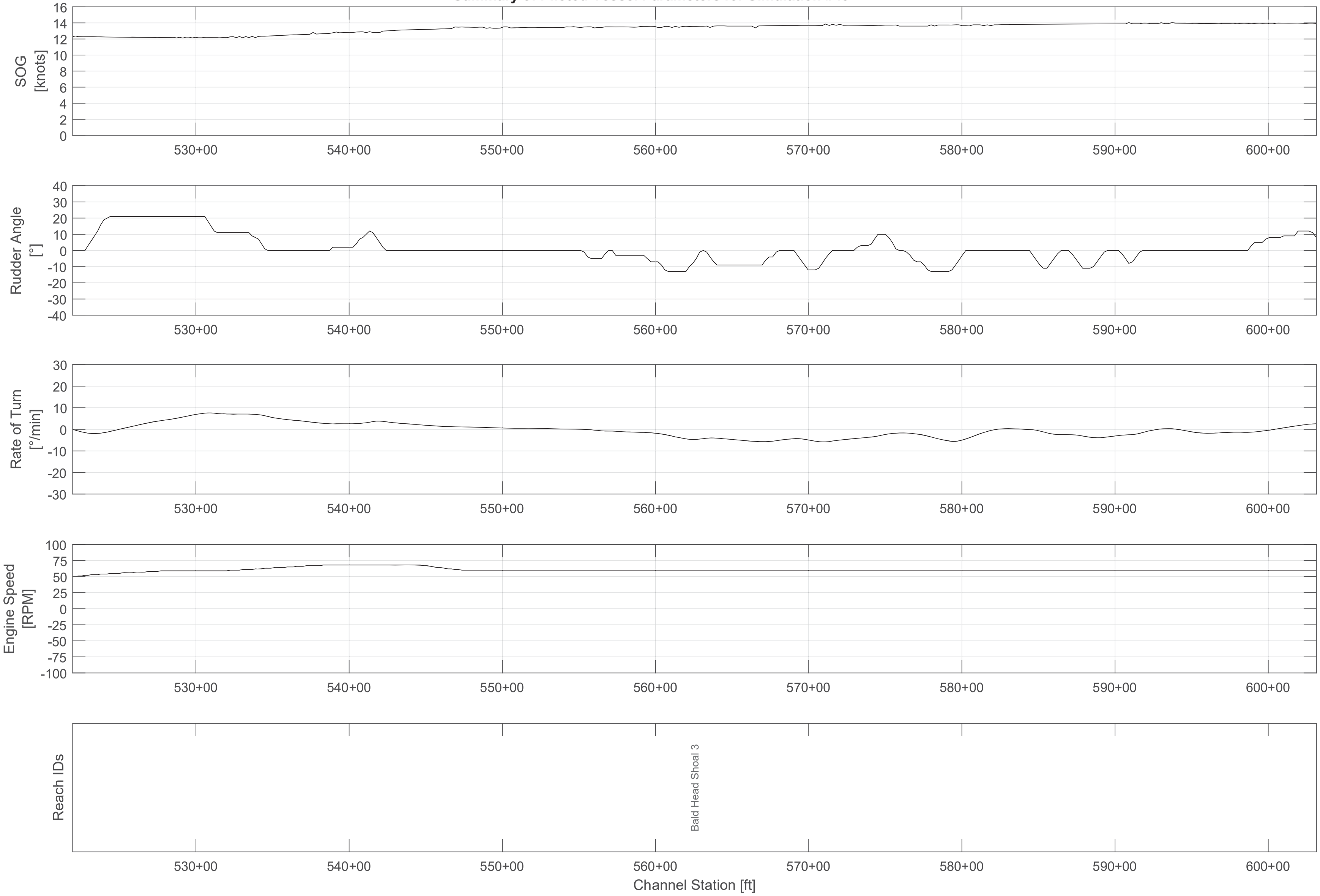
Summary of Piloted Vessel Parameters for Simulation #41

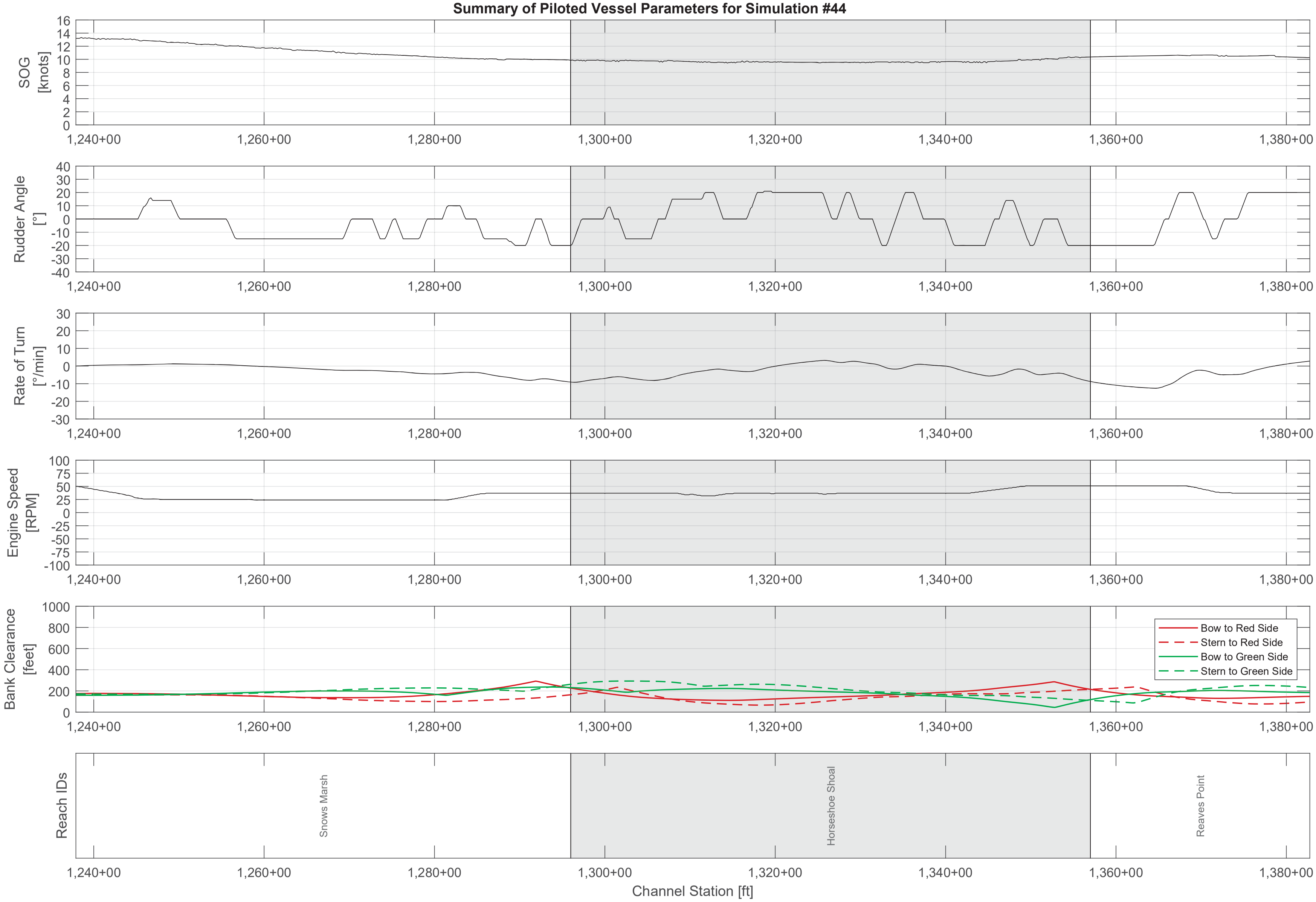


Summary of Piloted Vessel Parameters for Simulation #42

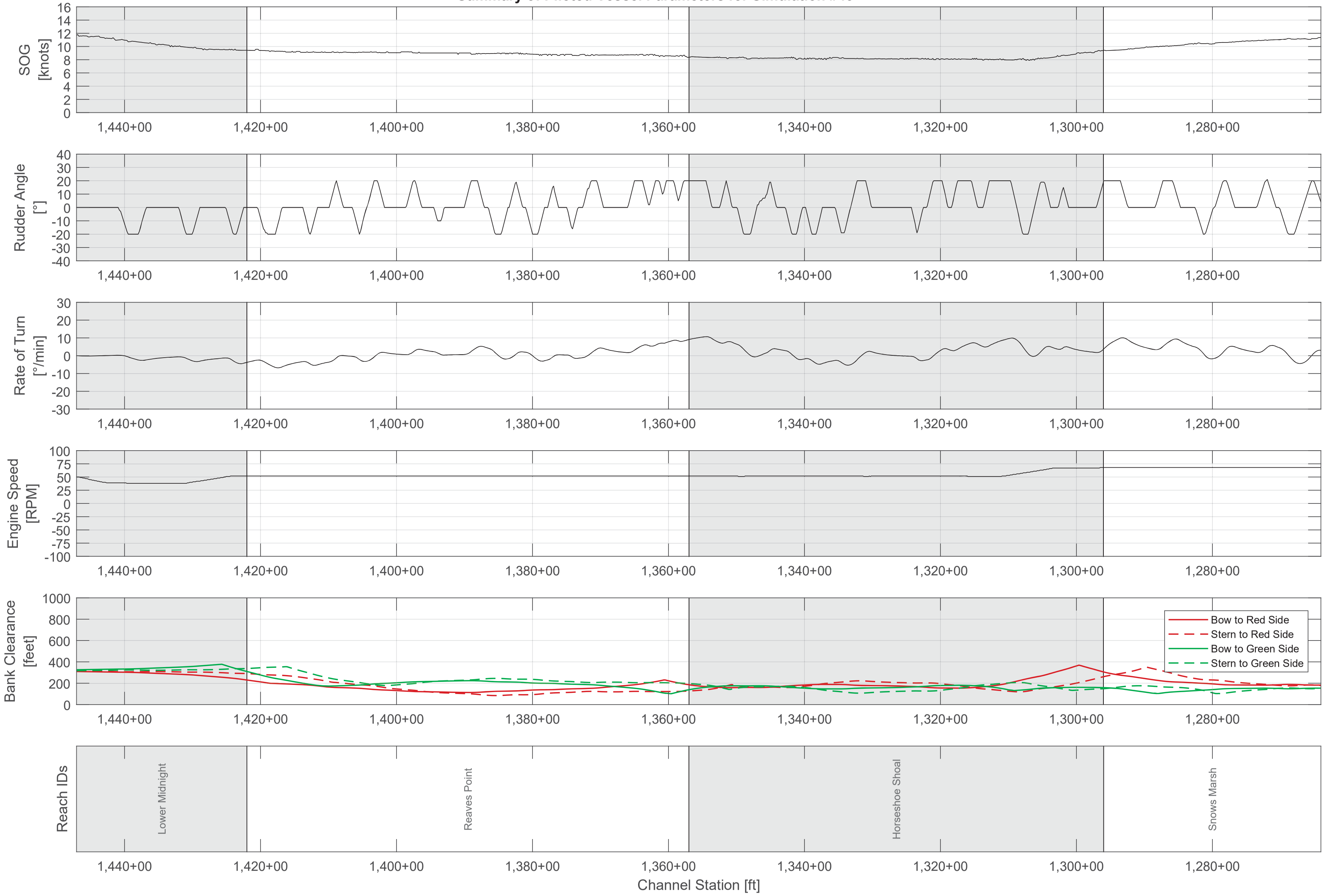


Summary of Piloted Vessel Parameters for Simulation #43

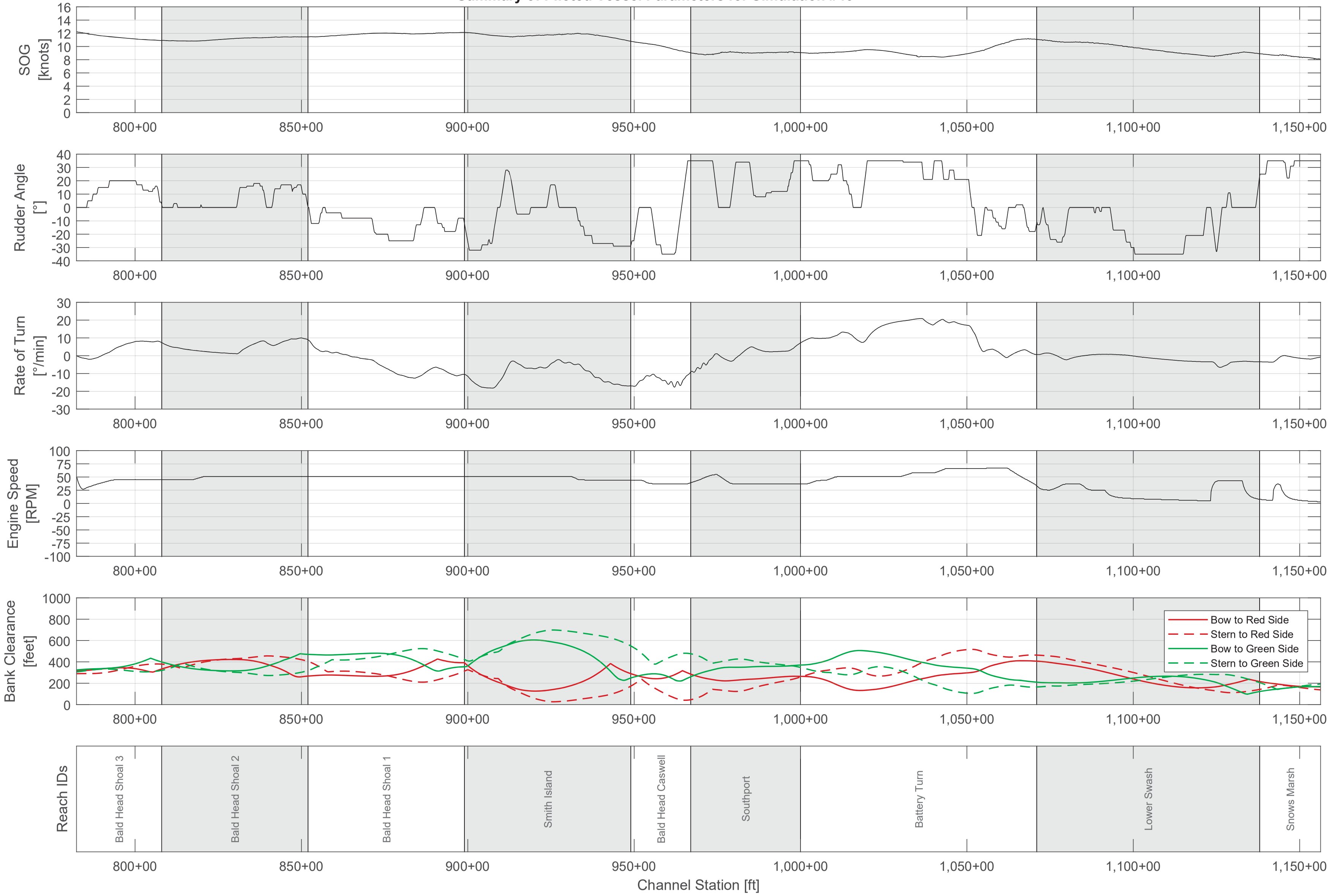



Summary of Piloted Vessel Parameters for Simulation #44

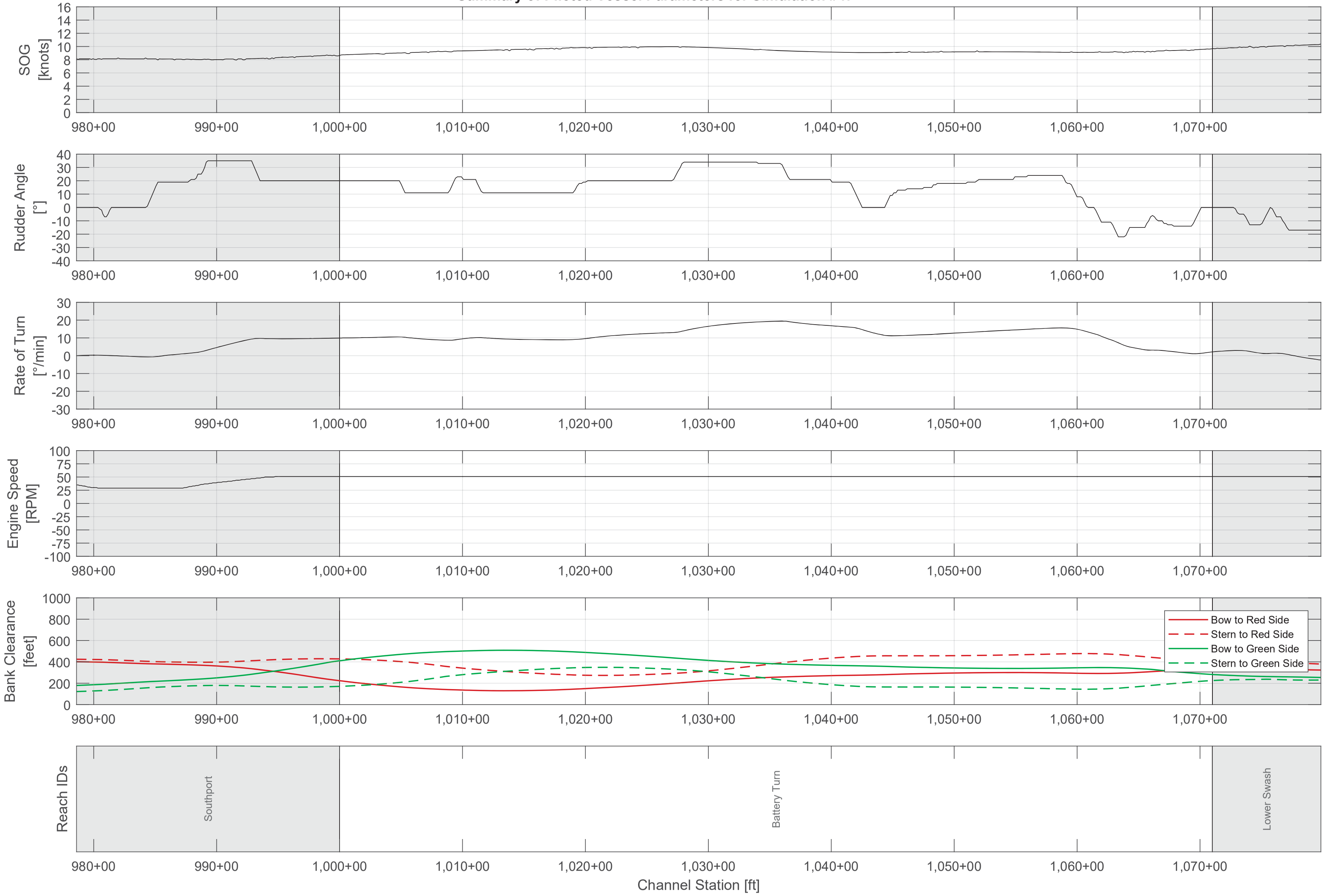
Summary of Piloted Vessel Parameters for Simulation #45



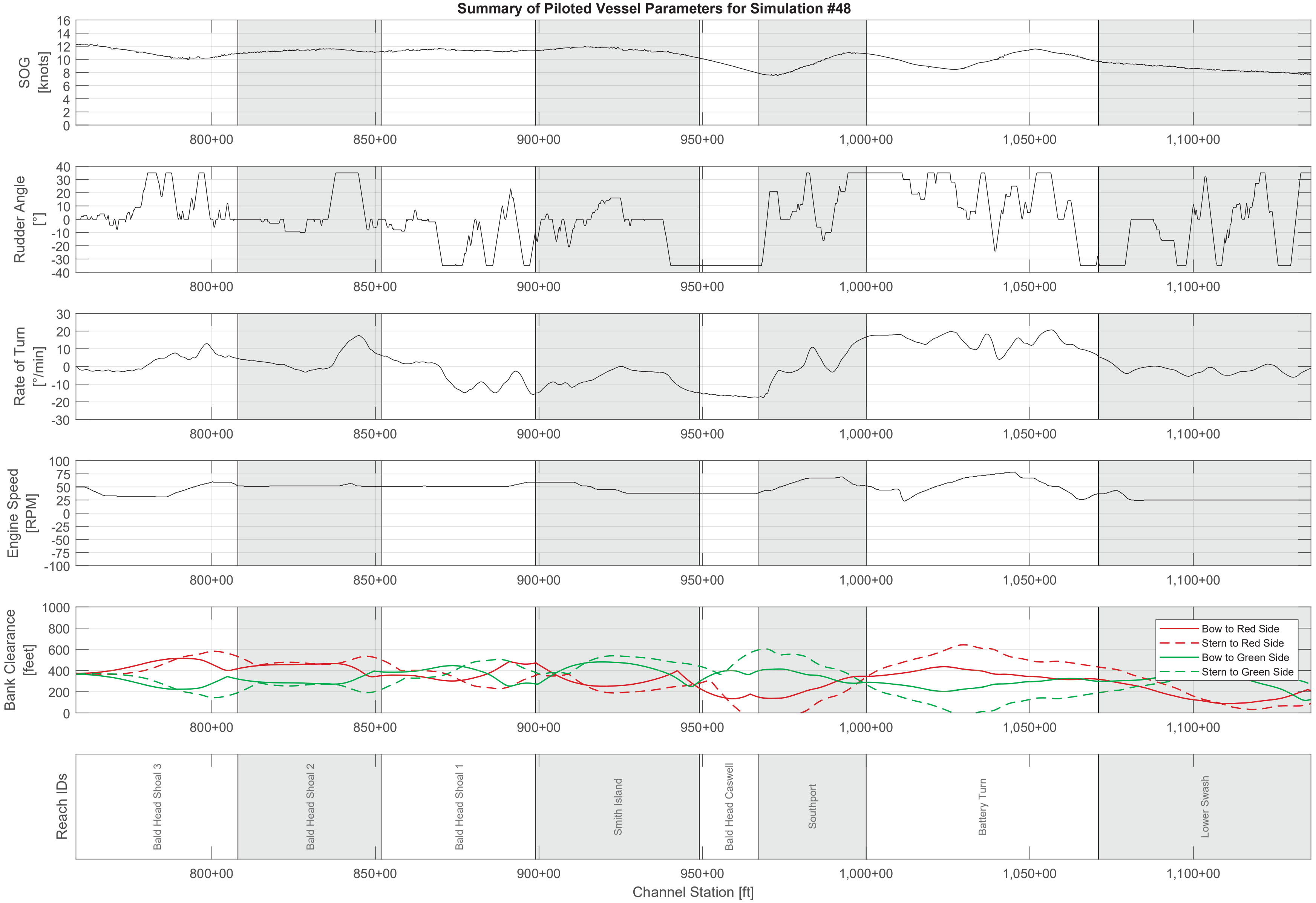
Summary of Piloted Vessel Parameters for Simulation #46



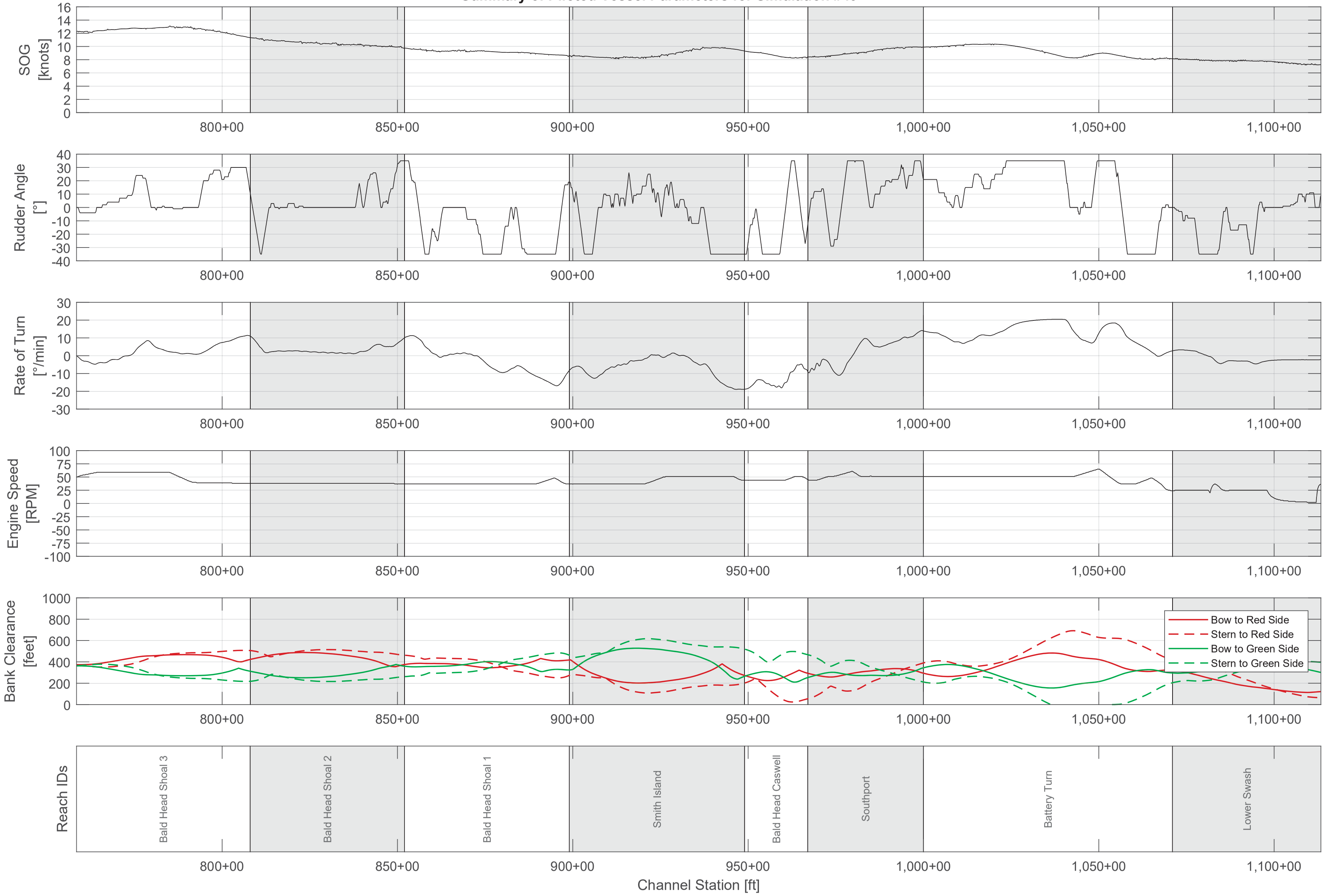
Summary of Piloted Vessel Parameters for Simulation #47



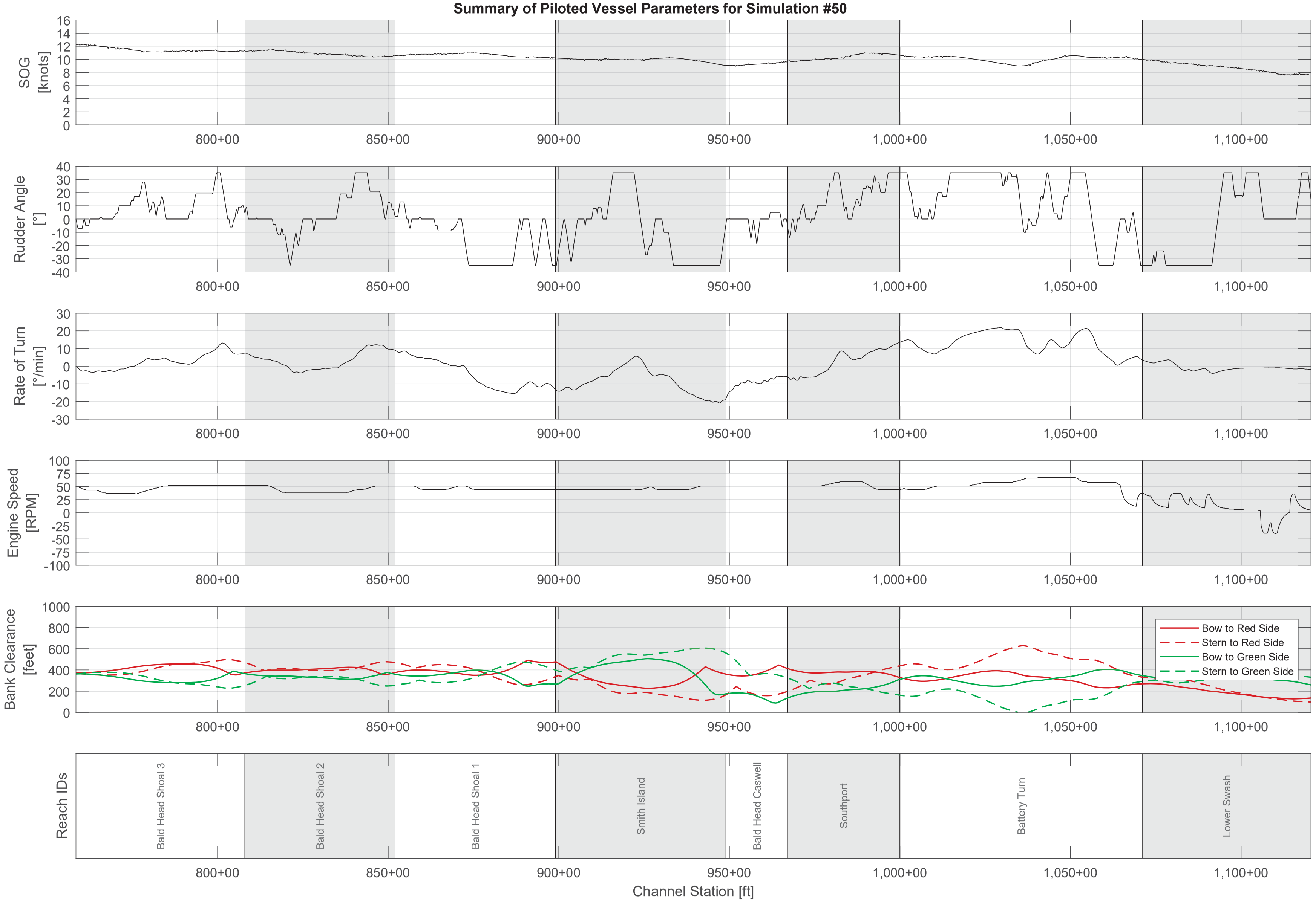
Summary of Piloted Vessel Parameters for Simulation #48



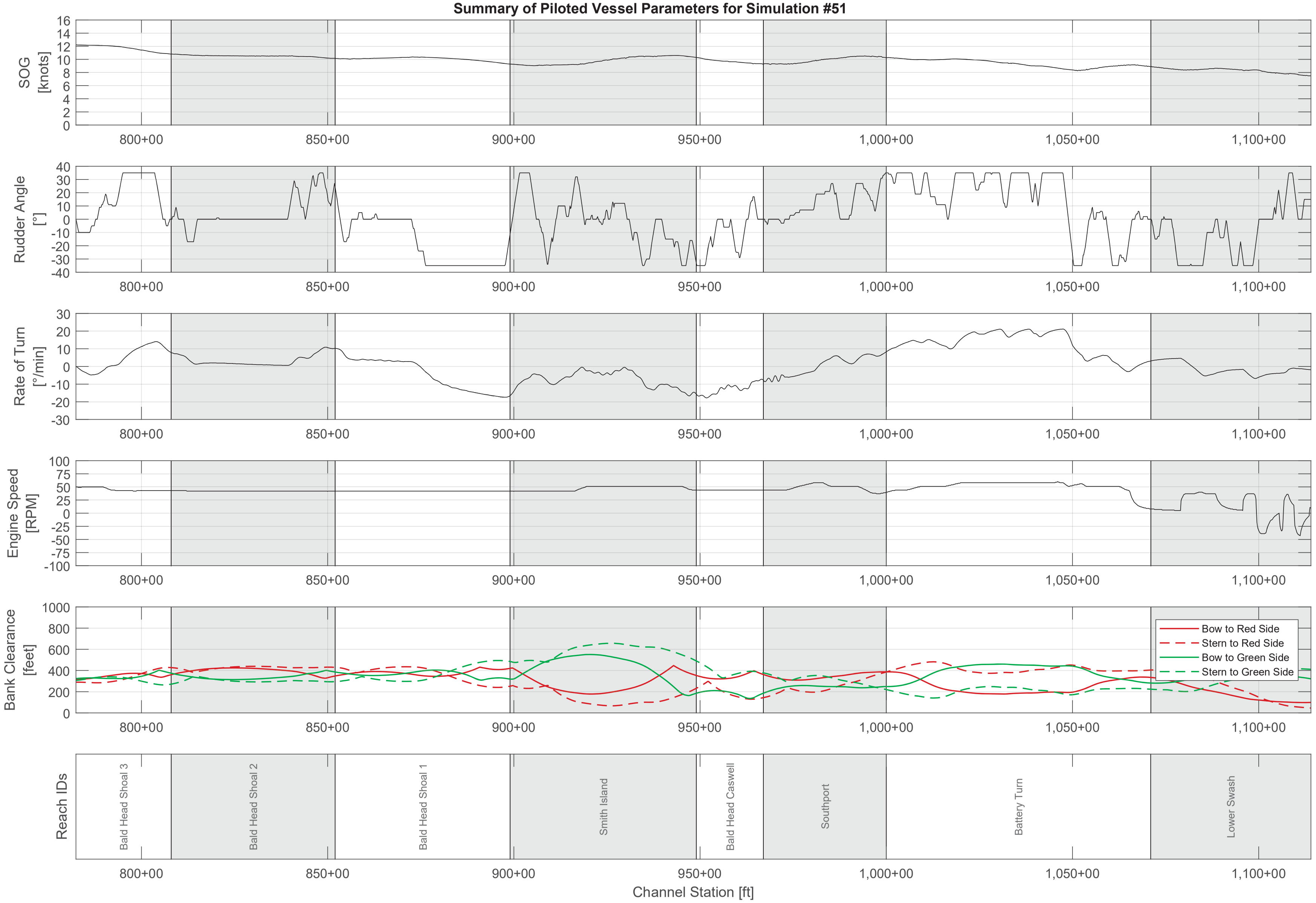
Summary of Piloted Vessel Parameters for Simulation #49



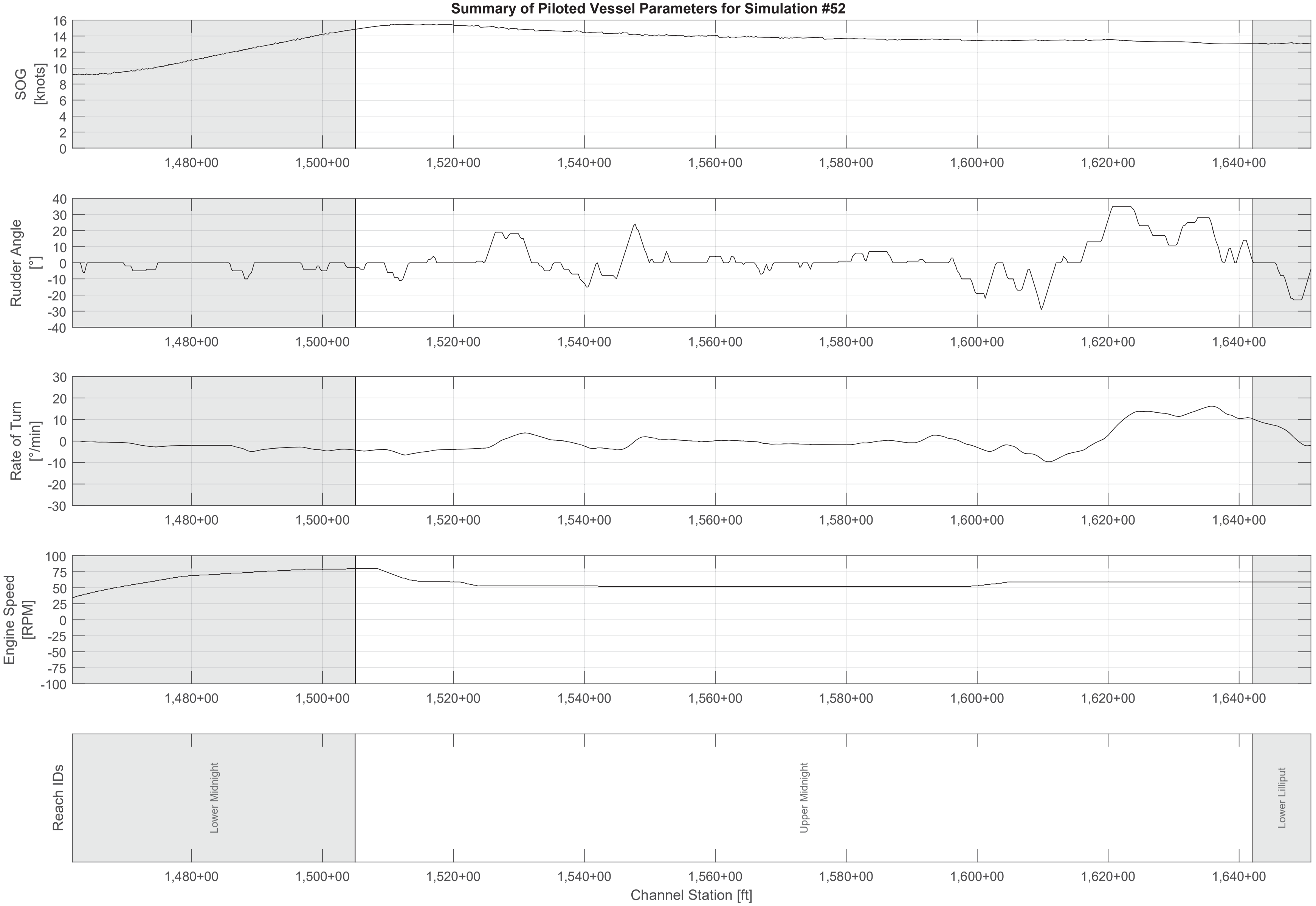
Summary of Piloted Vessel Parameters for Simulation #50



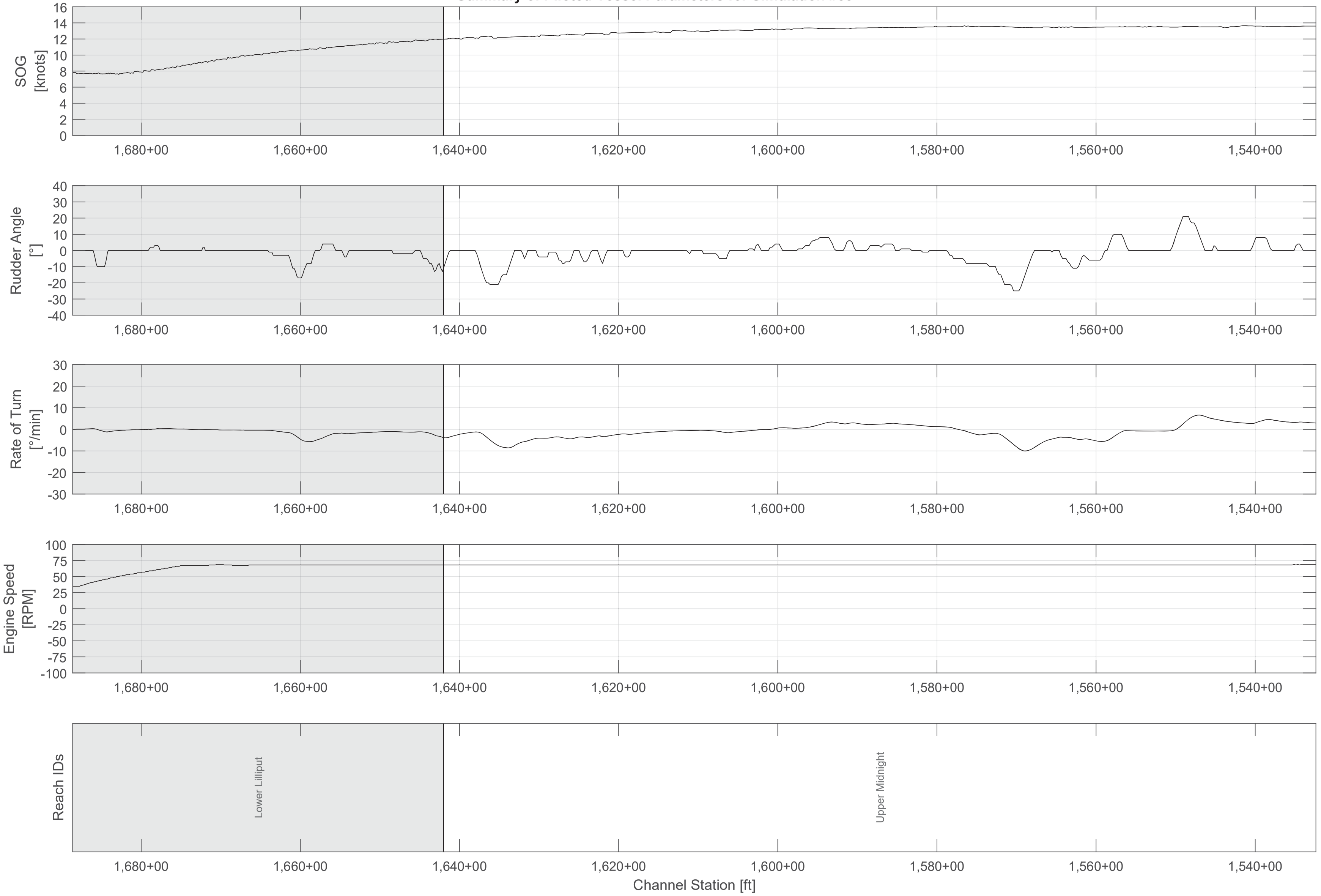
Summary of Piloted Vessel Parameters for Simulation #51



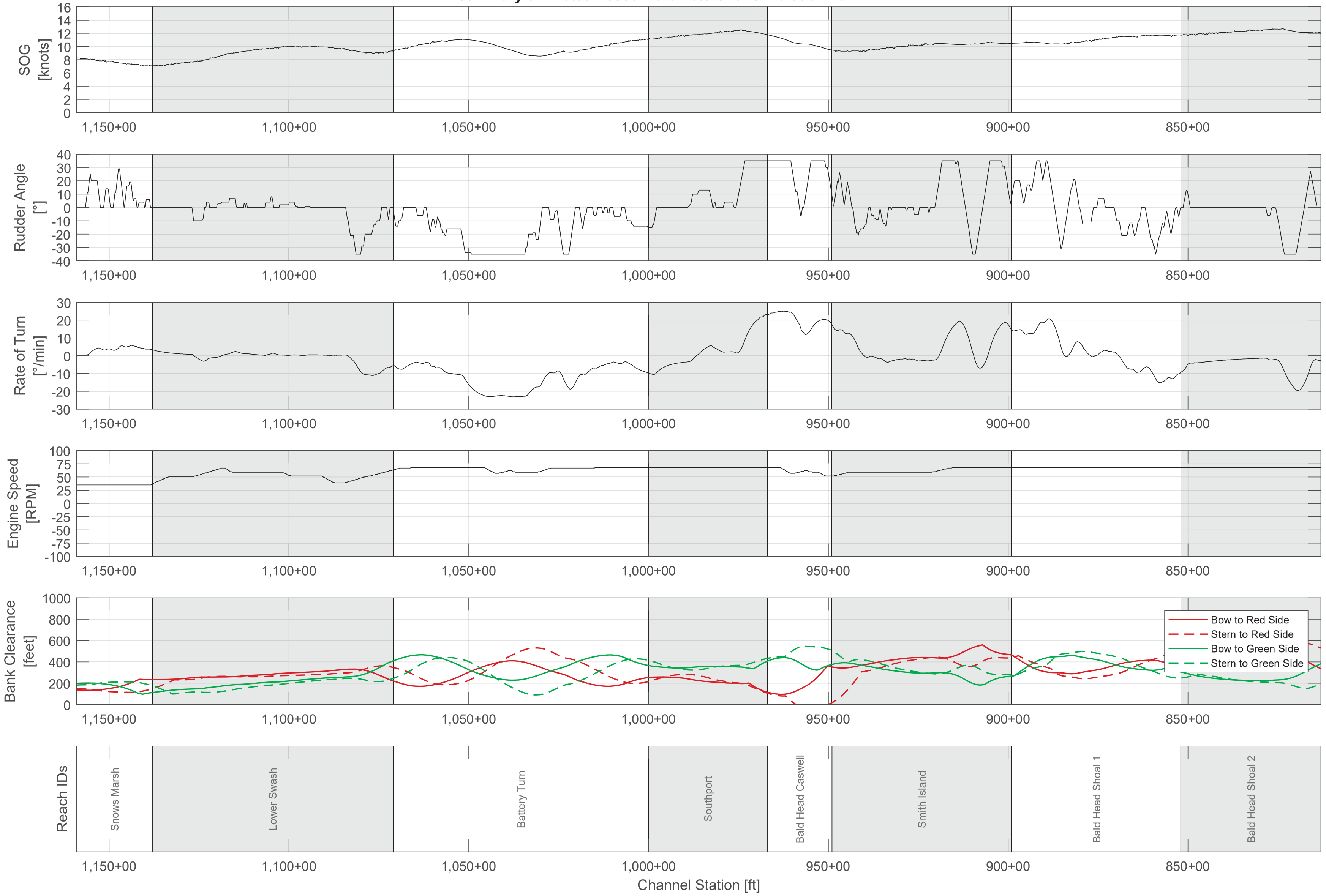
Summary of Piloted Vessel Parameters for Simulation #52



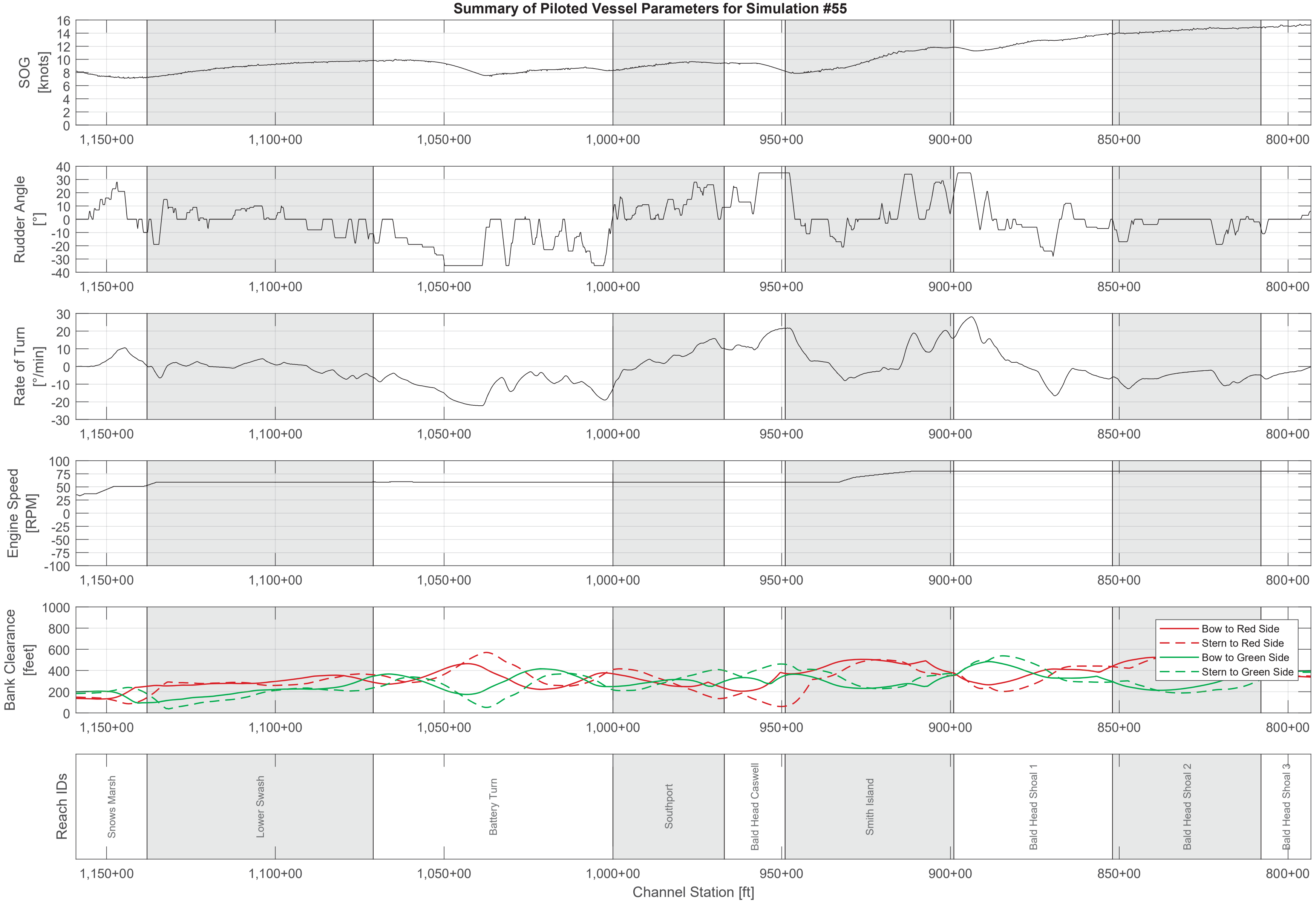
Summary of Piloted Vessel Parameters for Simulation #53

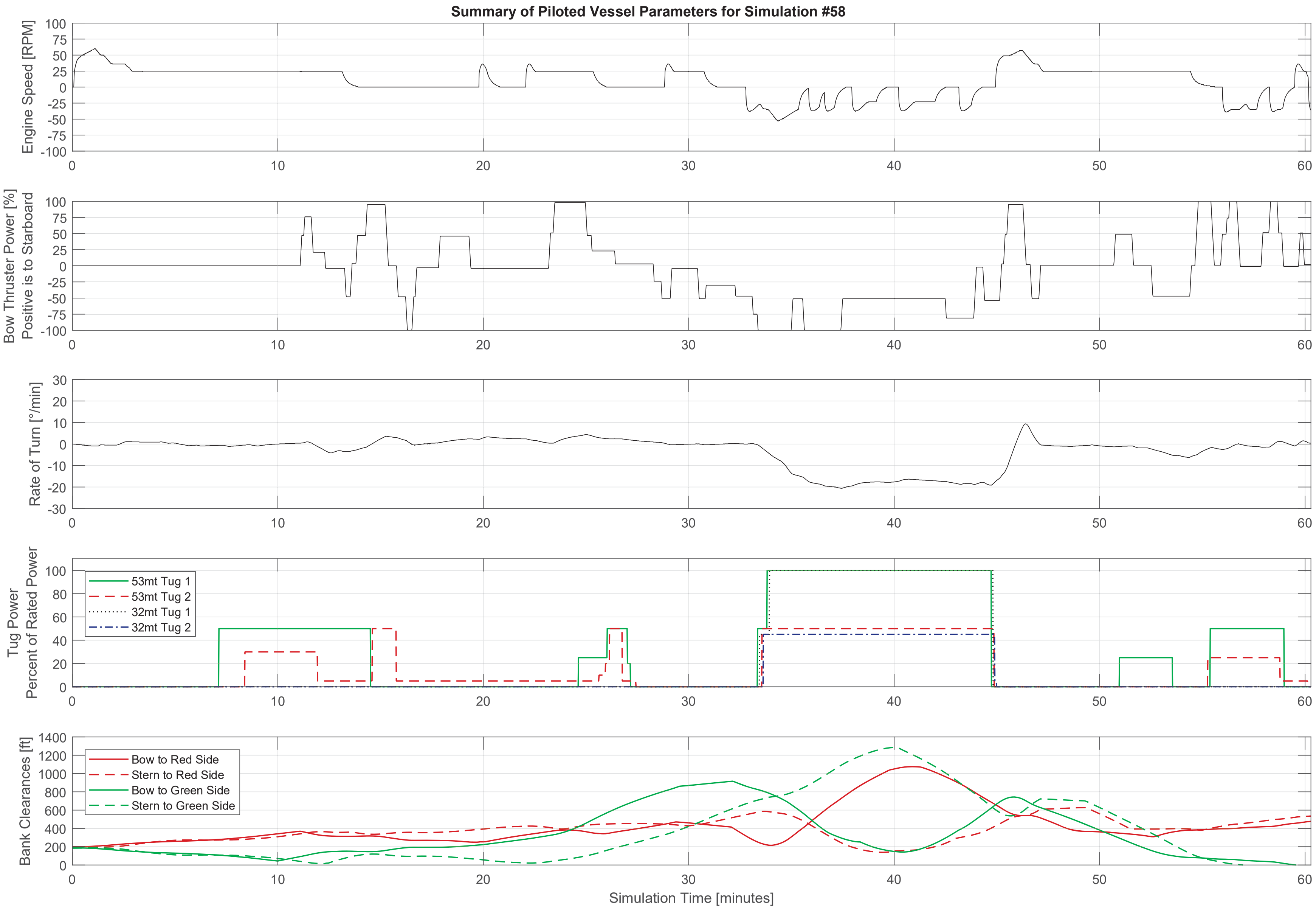


Summary of Piloted Vessel Parameters for Simulation #54

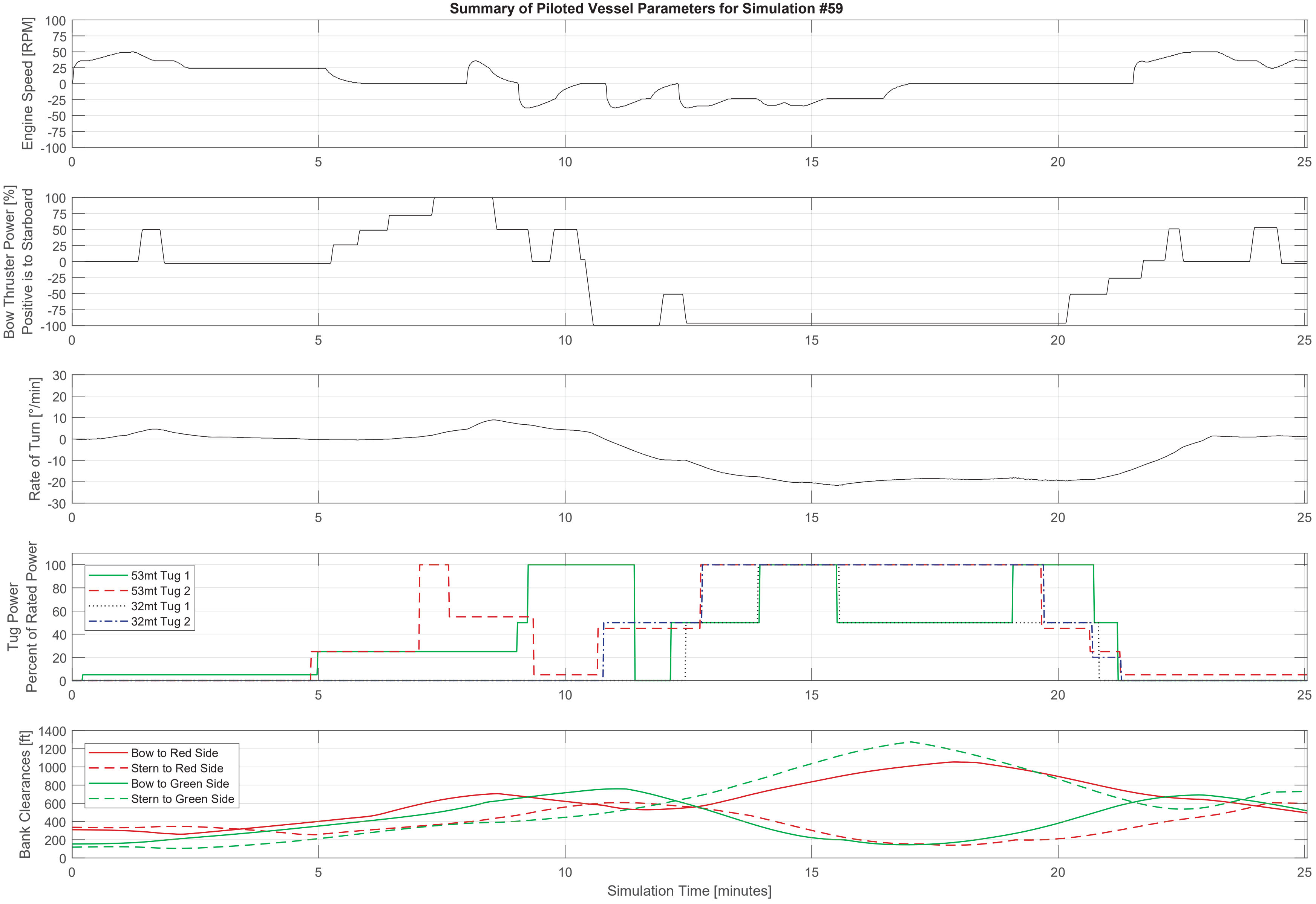


Summary of Piloted Vessel Parameters for Simulation #55

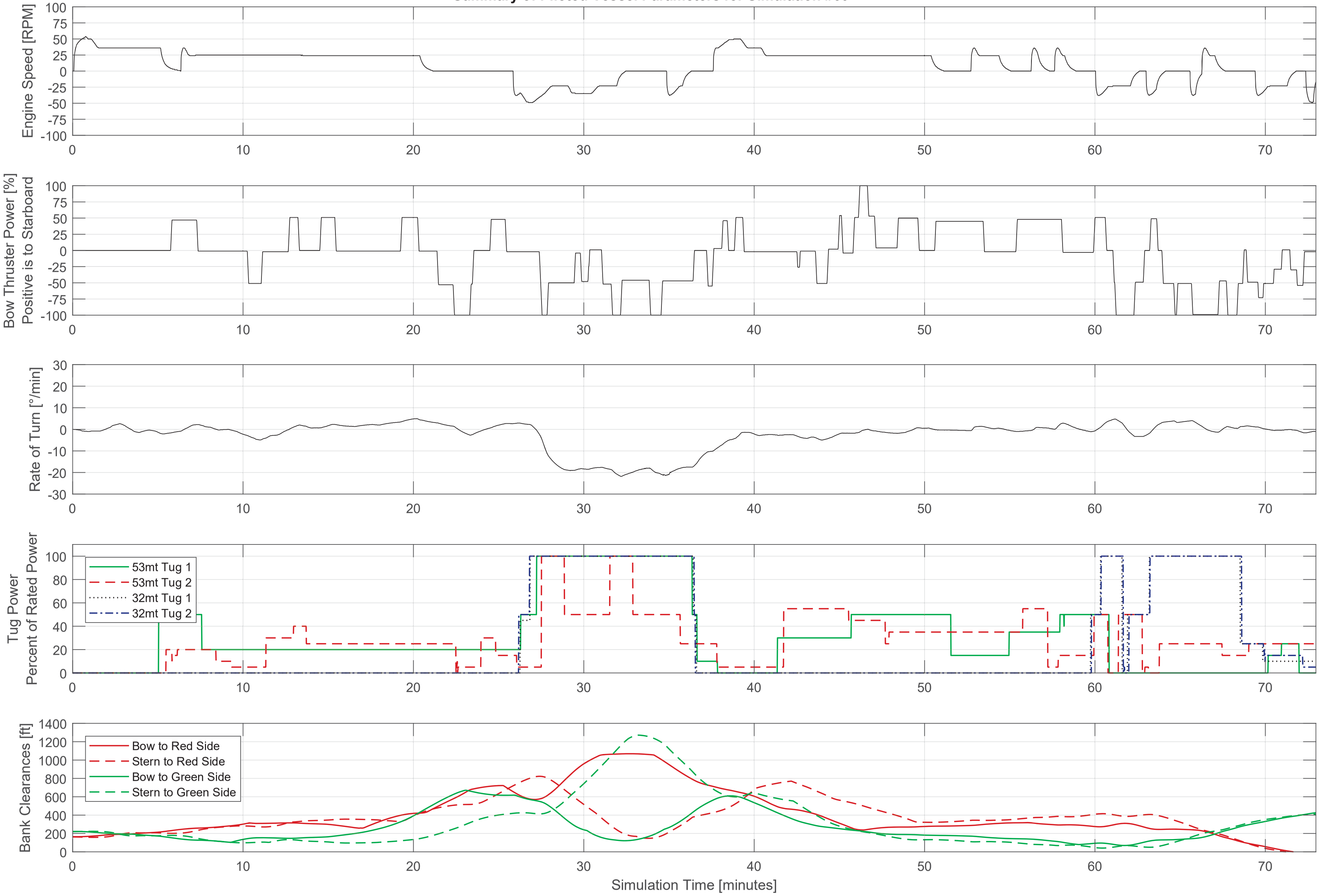



Summary of Piloted Vessel Parameters for Simulation #58

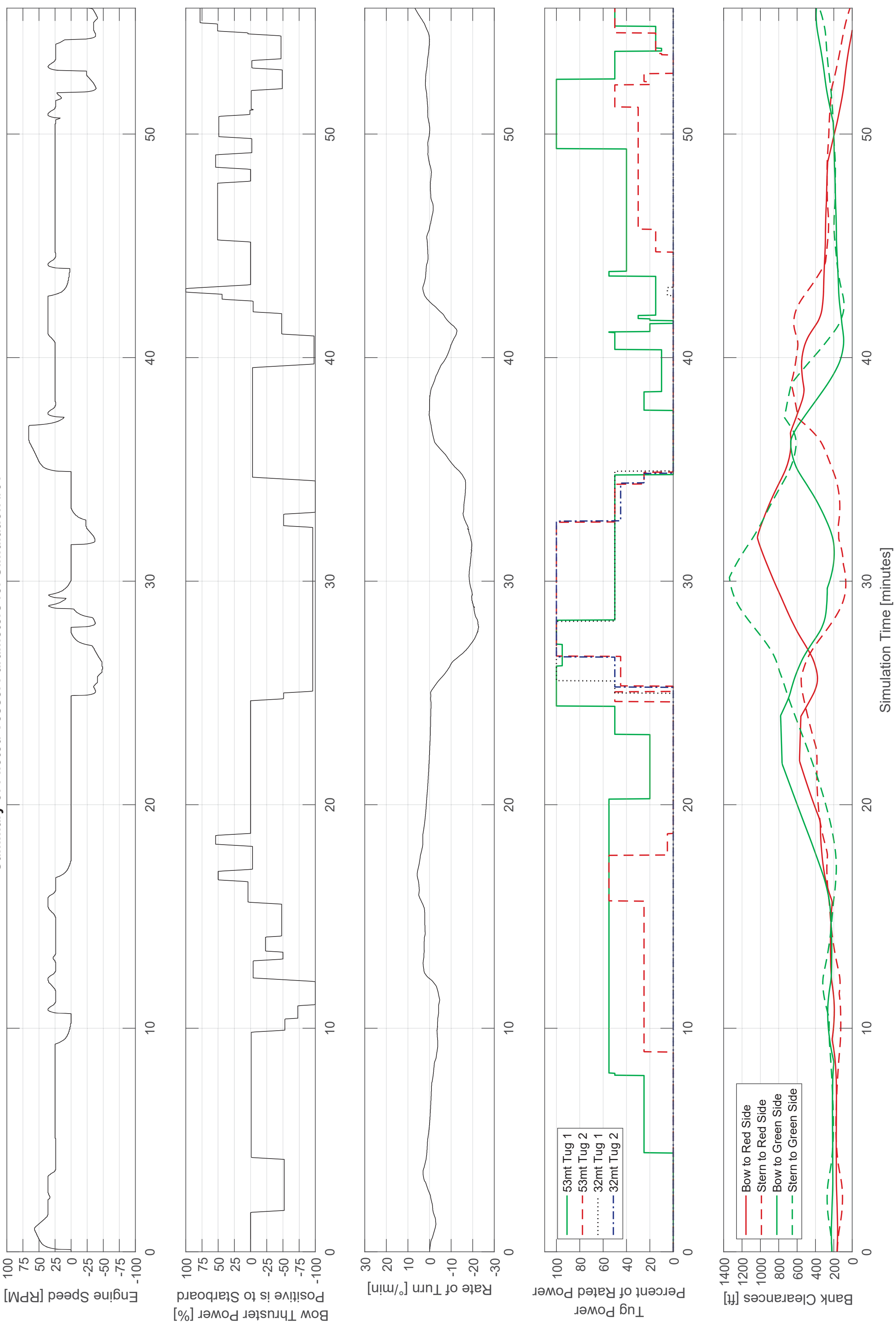
Summary of Piloted Vessel Parameters for Simulation #59

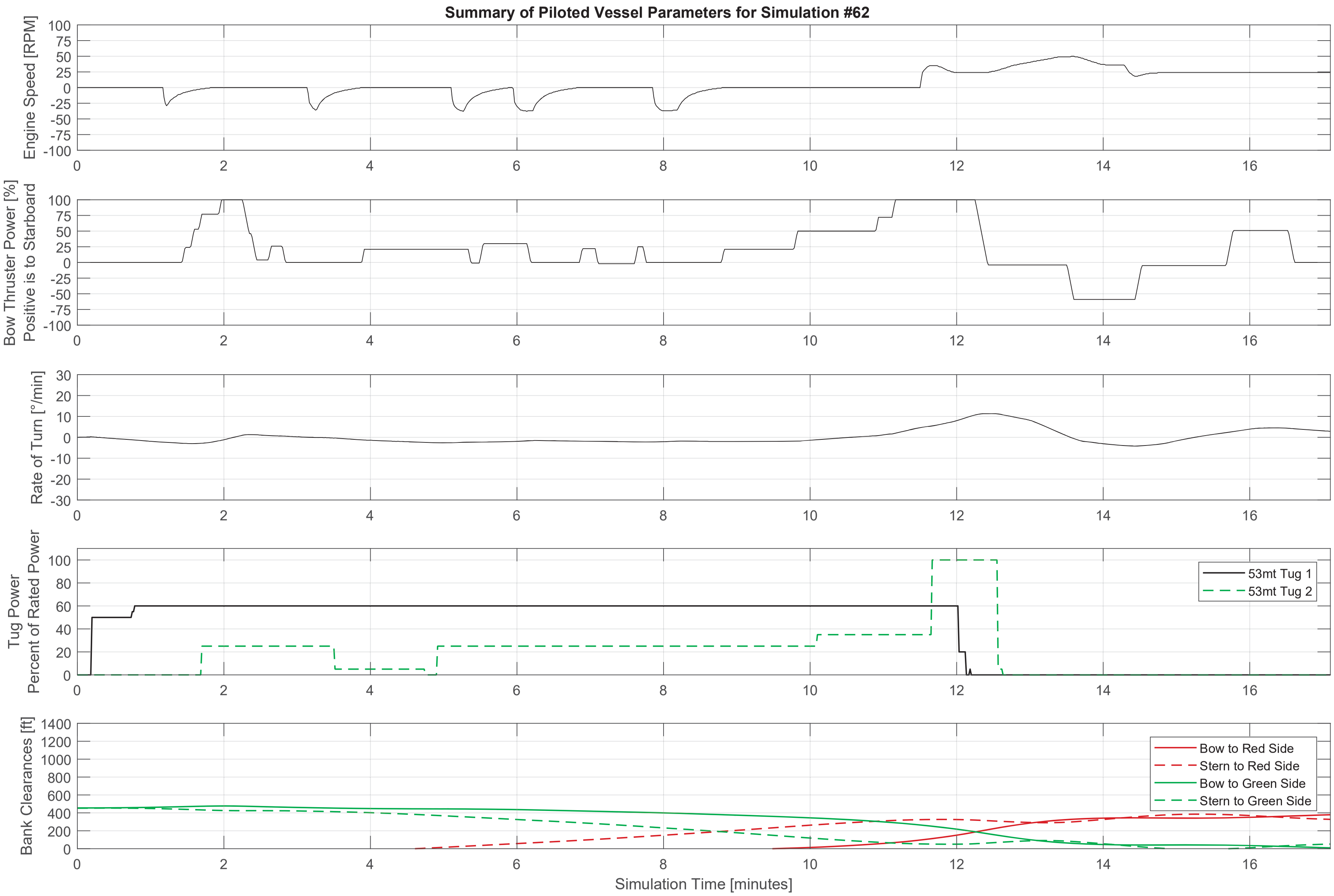


Summary of Piloted Vessel Parameters for Simulation #60

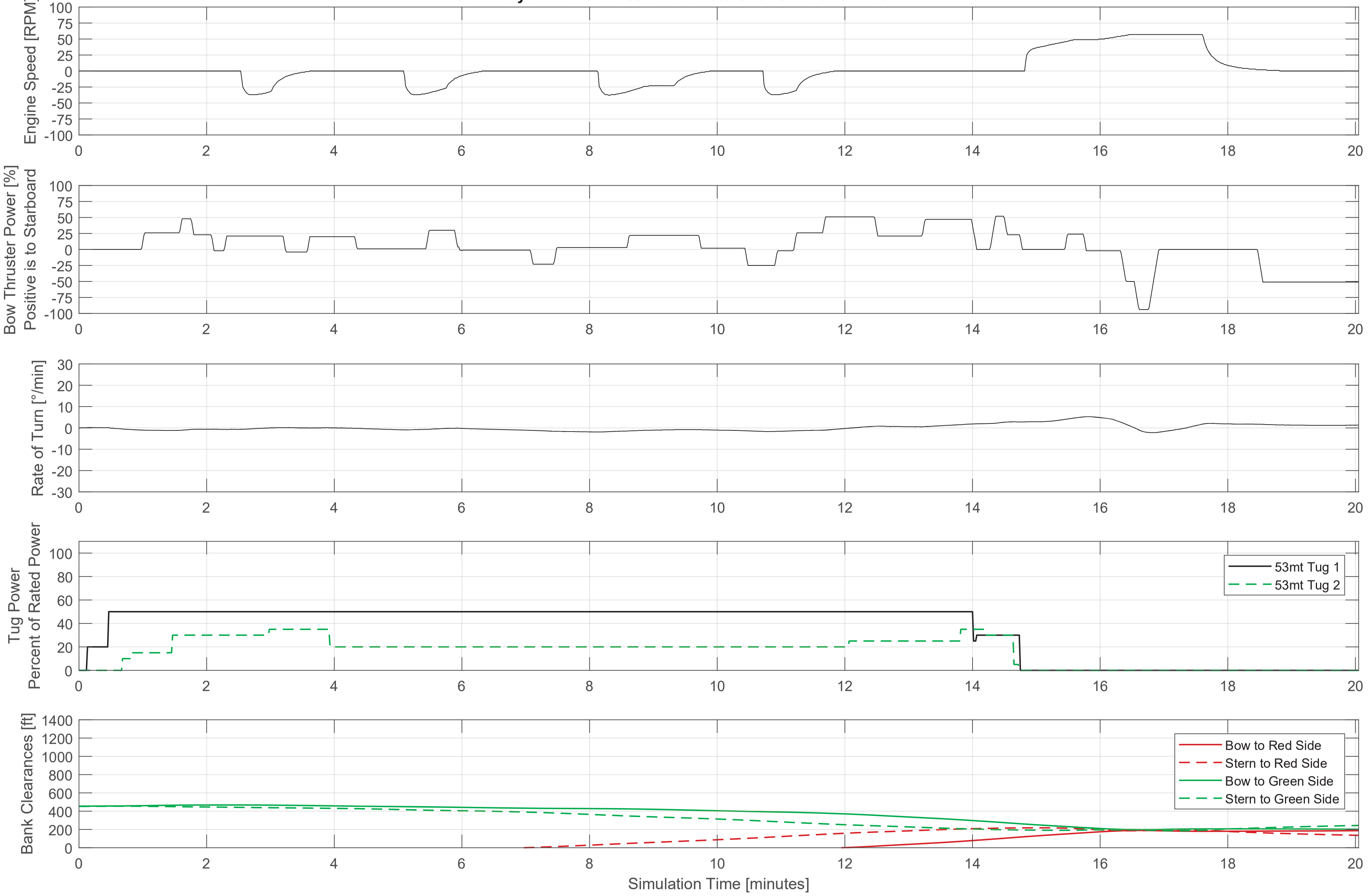


Summary of Piloted Vessel Parameters for Simulation #61



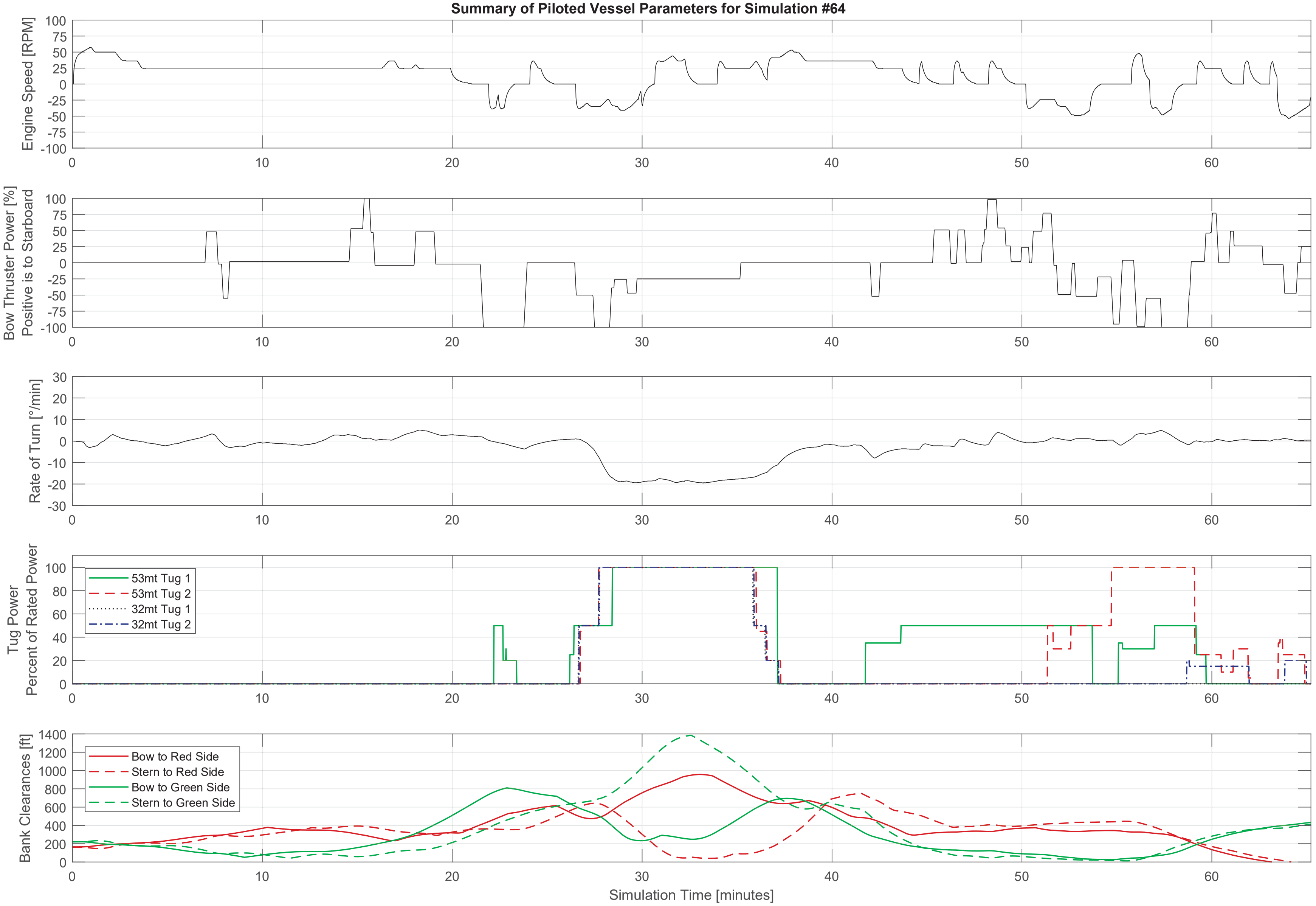


Summary of Piloted Vessel Parameters for Simulation #62

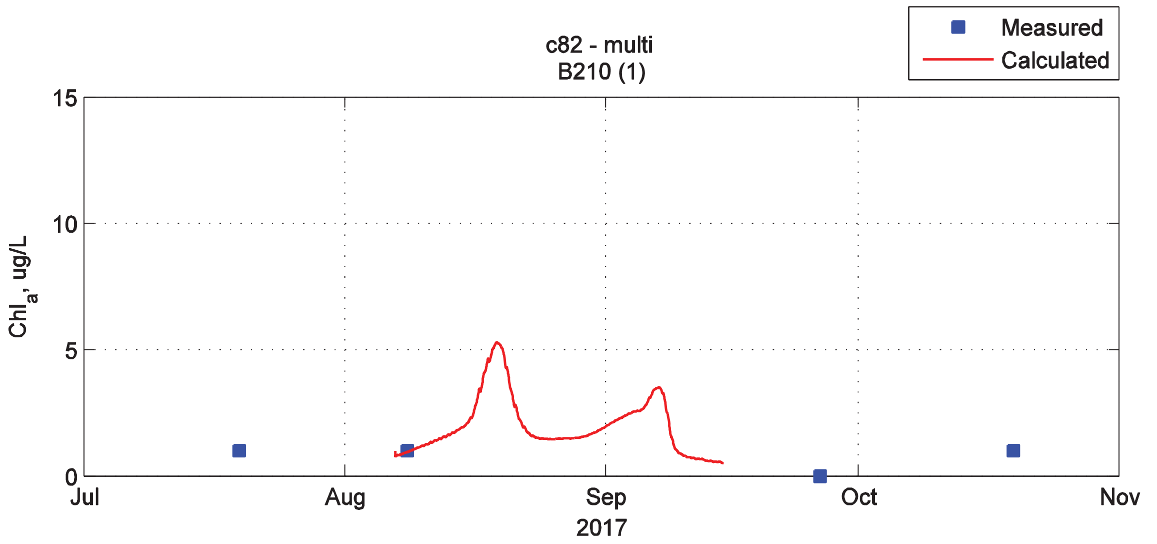


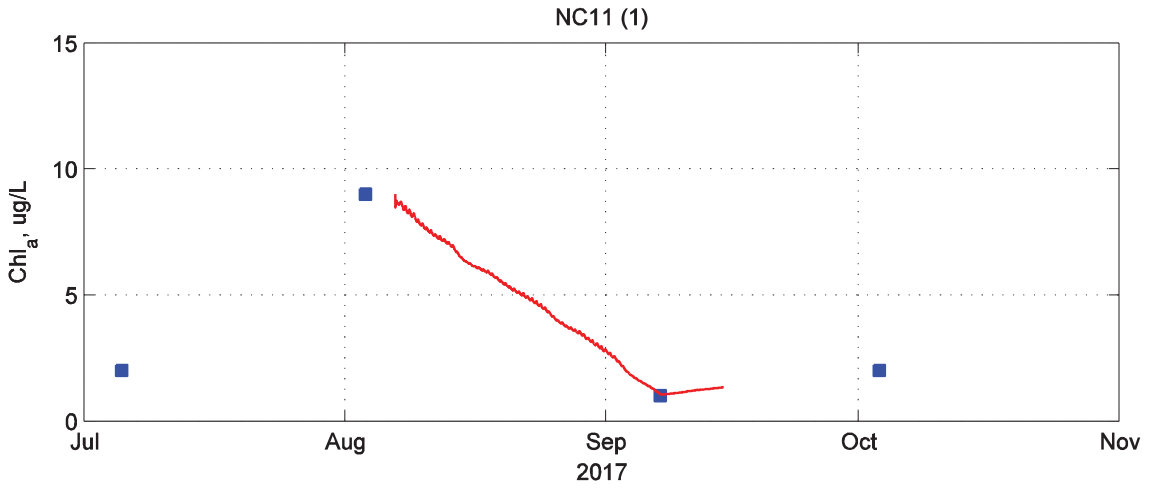
Summary of Piloted Vessel Parameters for Simulation #63

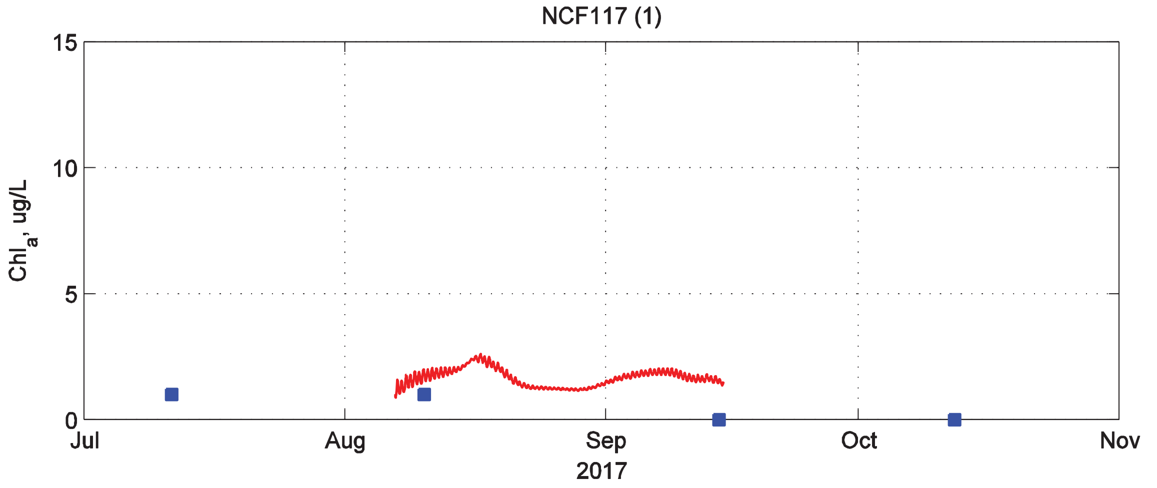
Summary of Piloted Vessel Parameters for Simulation #64

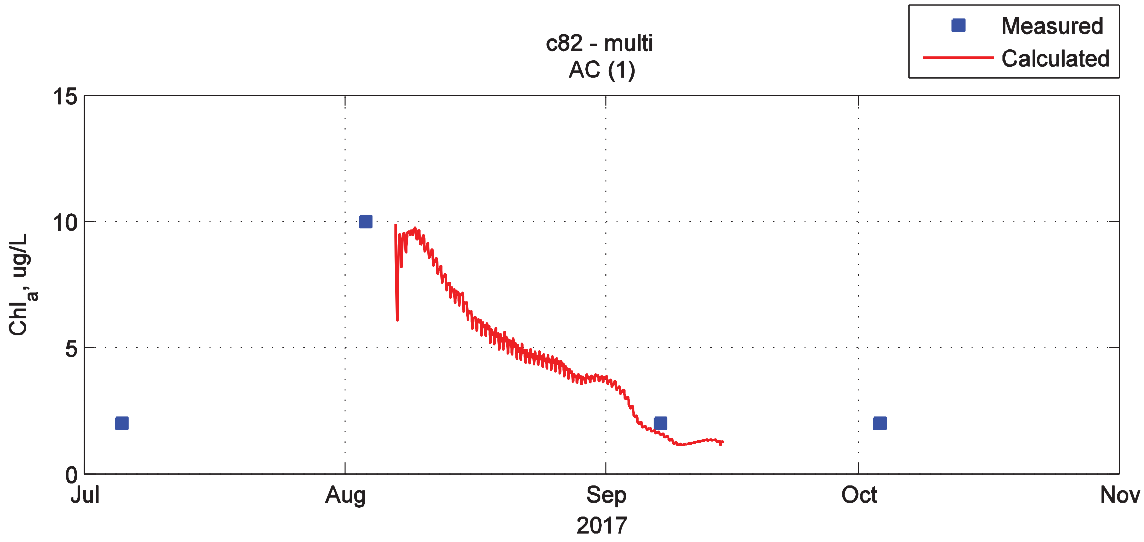


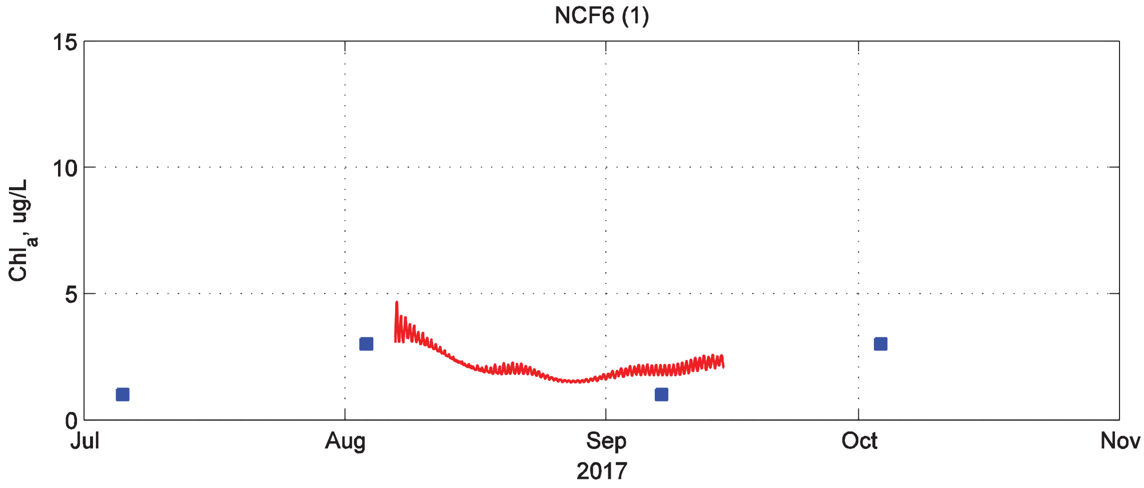
Appendix C–1:
Plots of Modeled & Measured Water Quality Constituents for Calibration

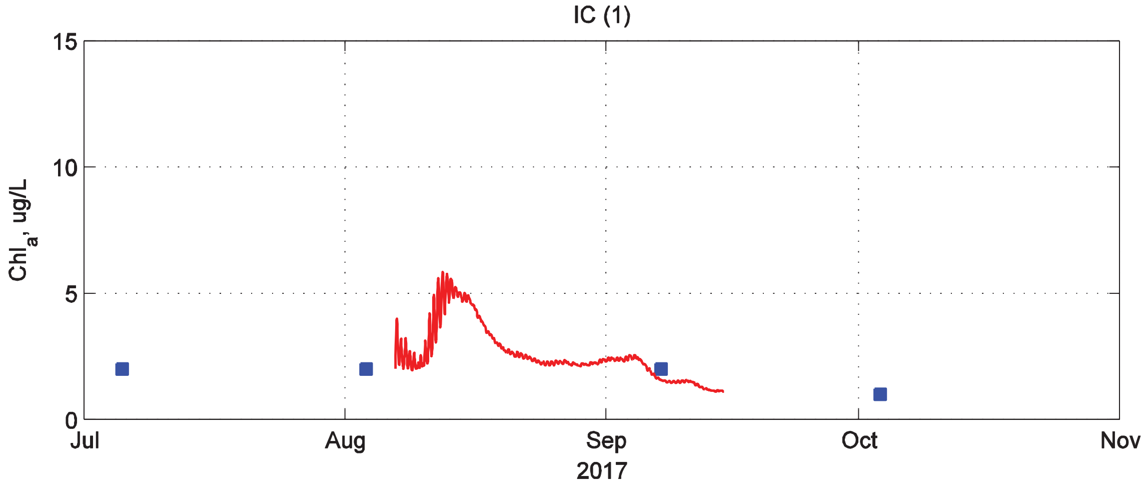

■ Measured
— Calculated
c82 - multi
B210 (1)
Chl$_a$, ug/L
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

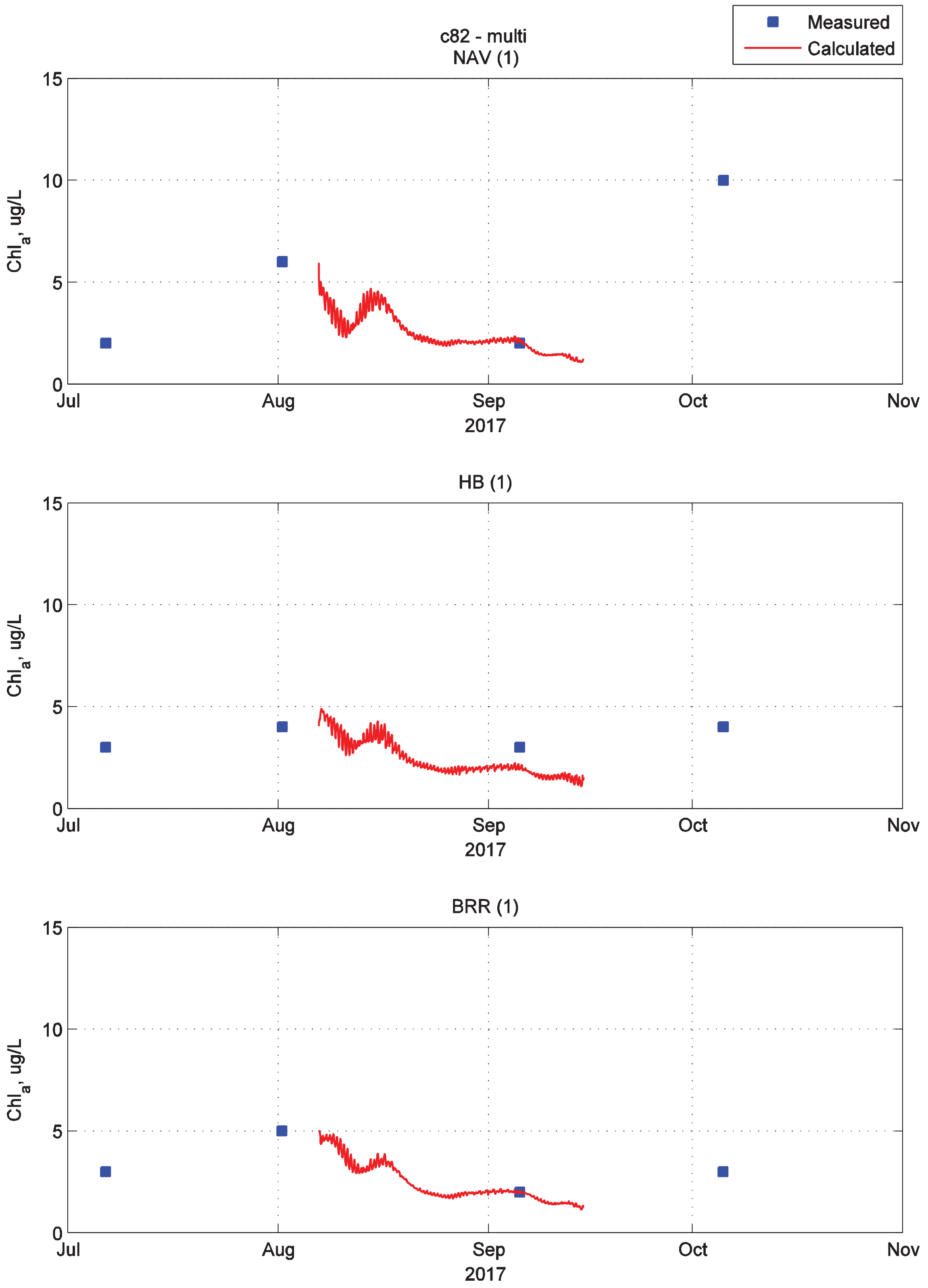

NC11 (1)
Chl$_a$, ug/L
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

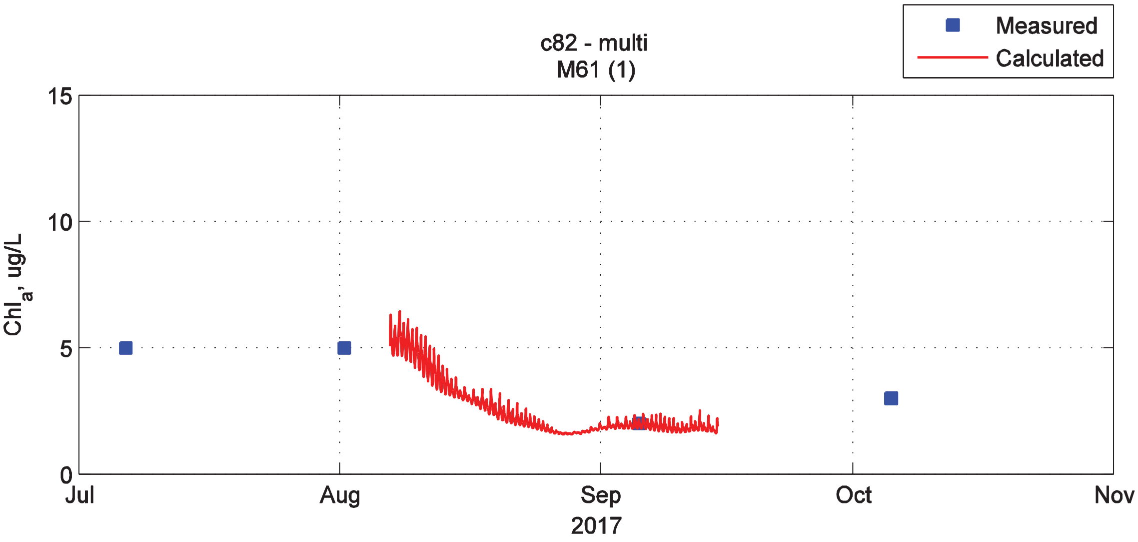

NCF117 (1)
Chl$_a$, ug/L
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

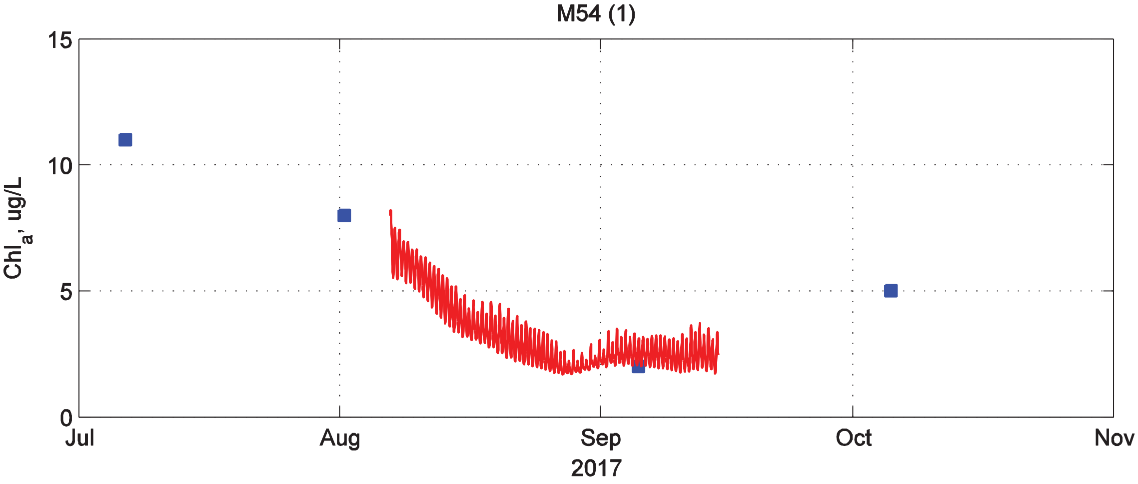

■ Measured
— Calculated
c82 - multi
AC (1)
Chl$_a$, ug/L
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

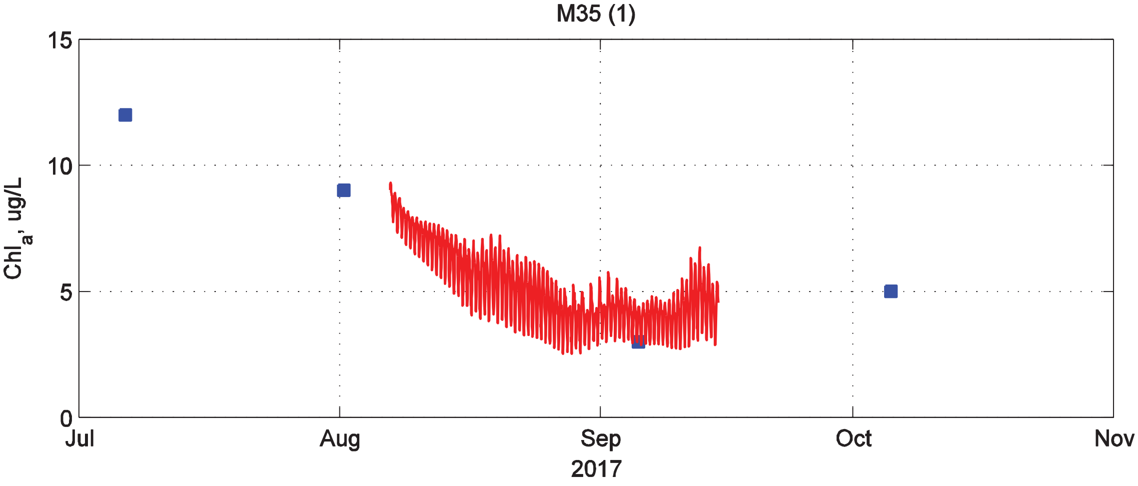

NCF6 (1)
Chl$_a$, ug/L
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

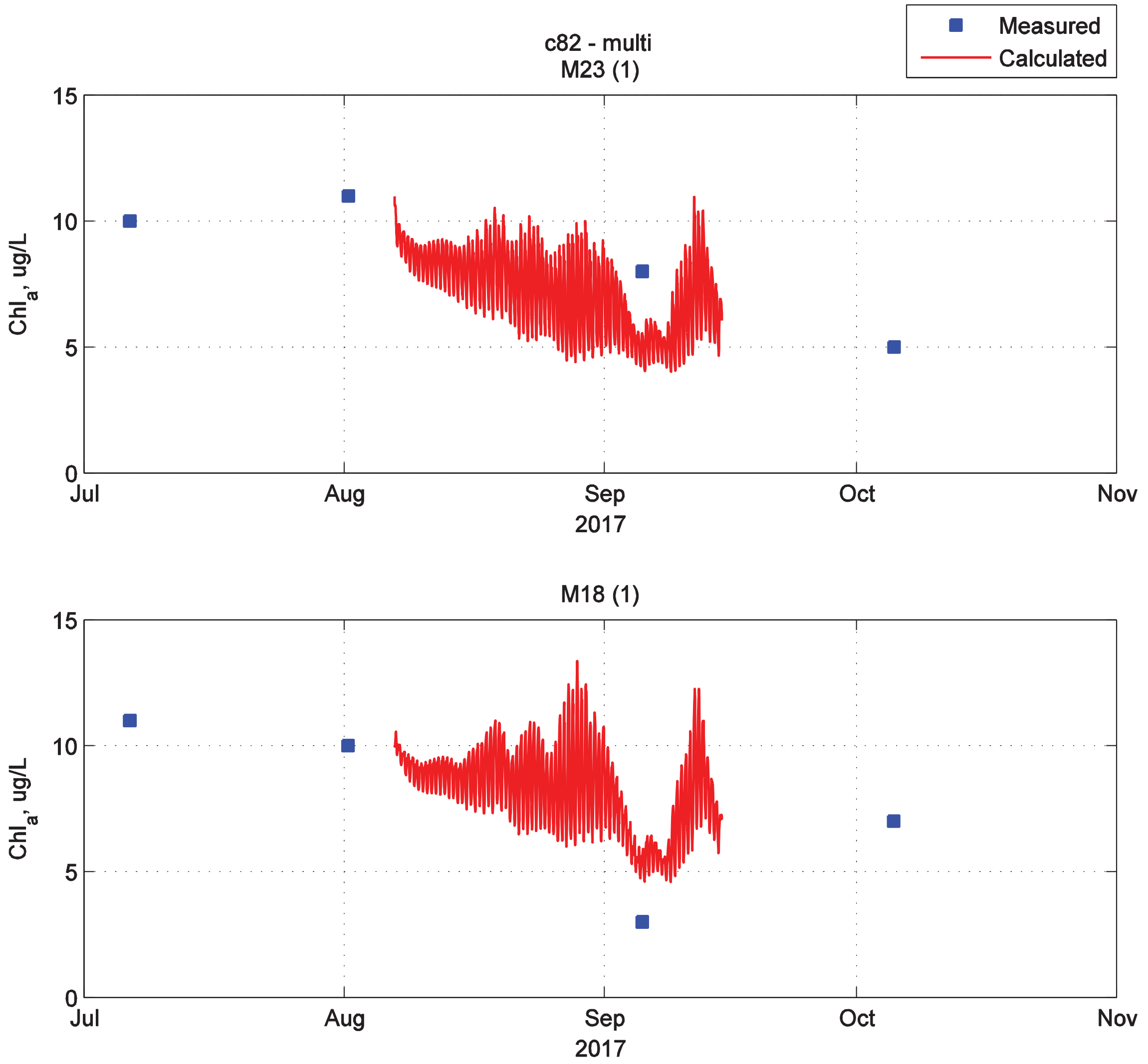

IC (1)
Chl$_a$, ug/L
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

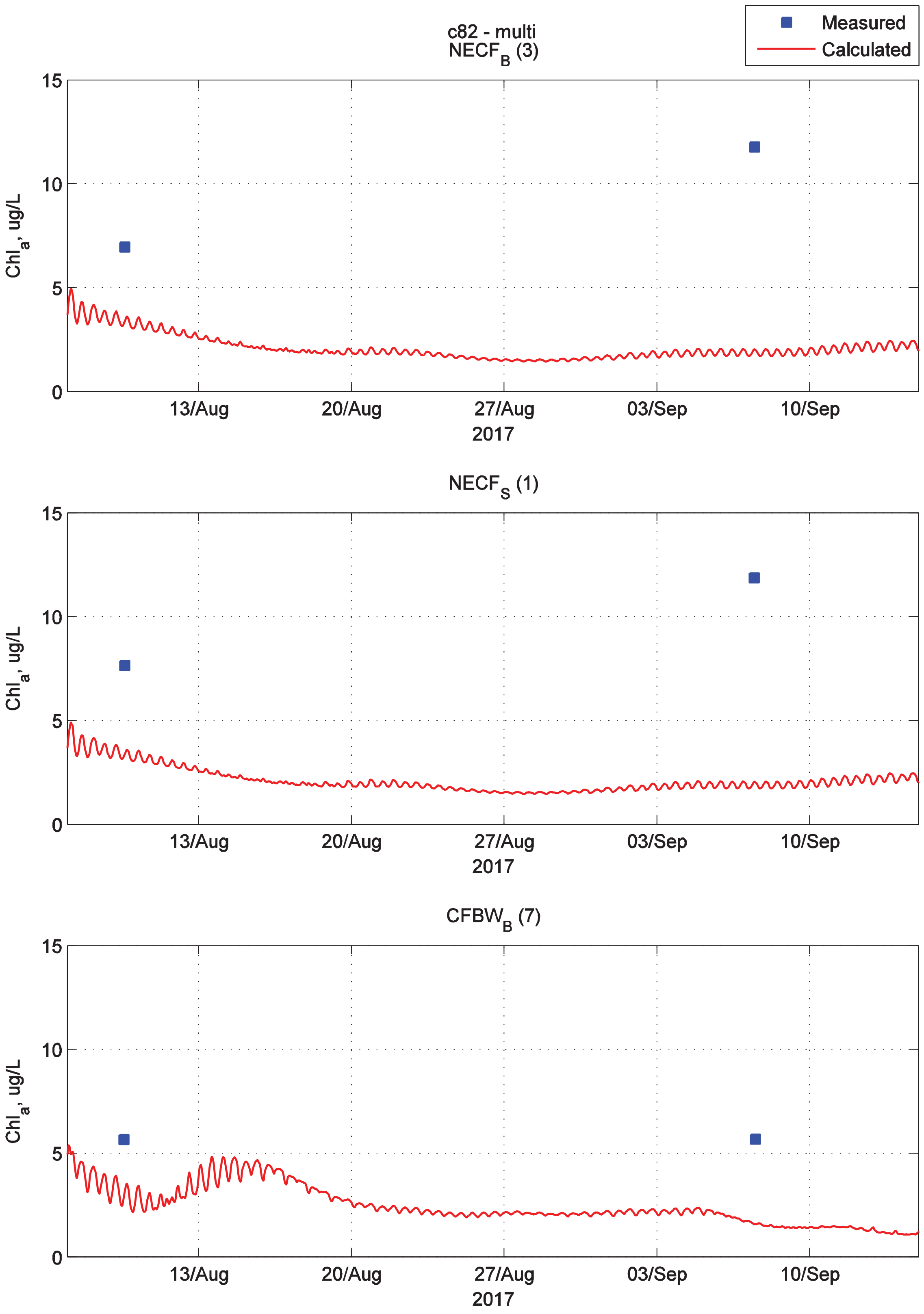

Measured
Calculated
c82 - multi
NAV (1)
15
10
5
0
Chl$_a$, ug/L
Jul
Aug
Sep
Oct
Nov
2017
HB (1)
15
10
5
0
Chl$_a$, ug/L
Jul
Aug
Sep
Oct
Nov
2017
BRR (1)
15
10
5
0
Chl$_a$, ug/L
Jul
Aug
Sep
Oct
Nov
2017

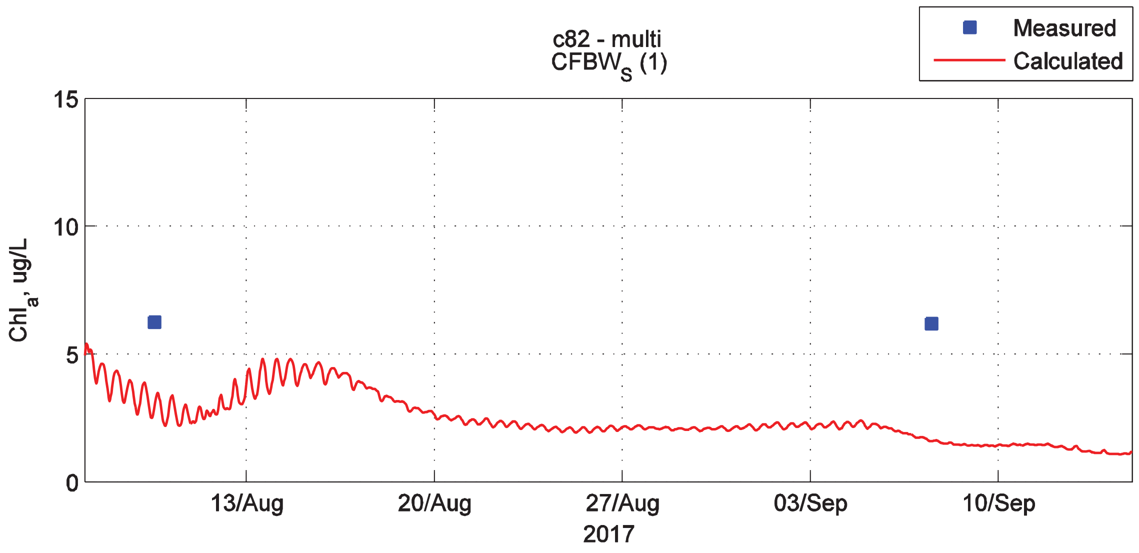

c82 - multi
M61 (1)

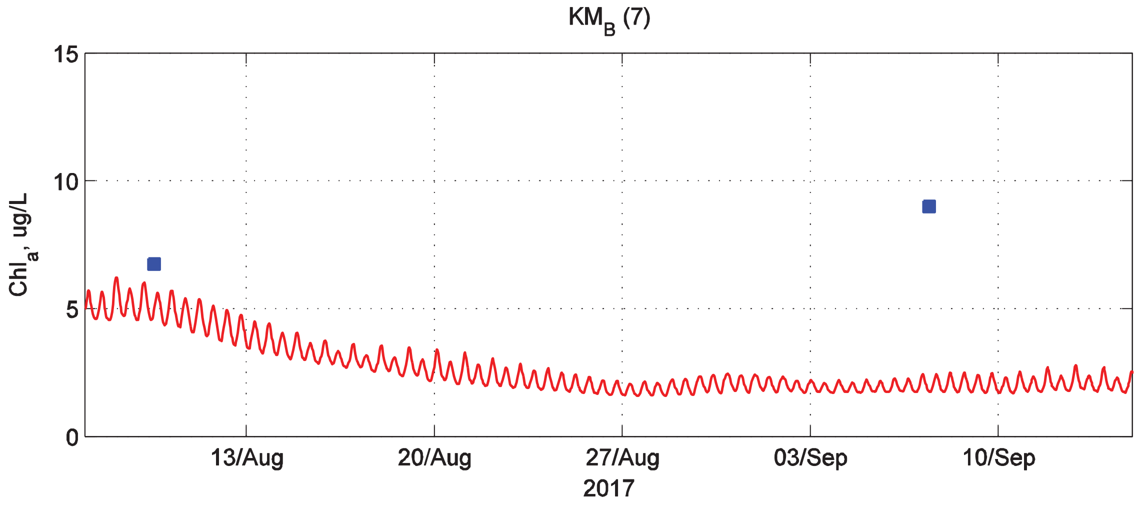

M54 (1)

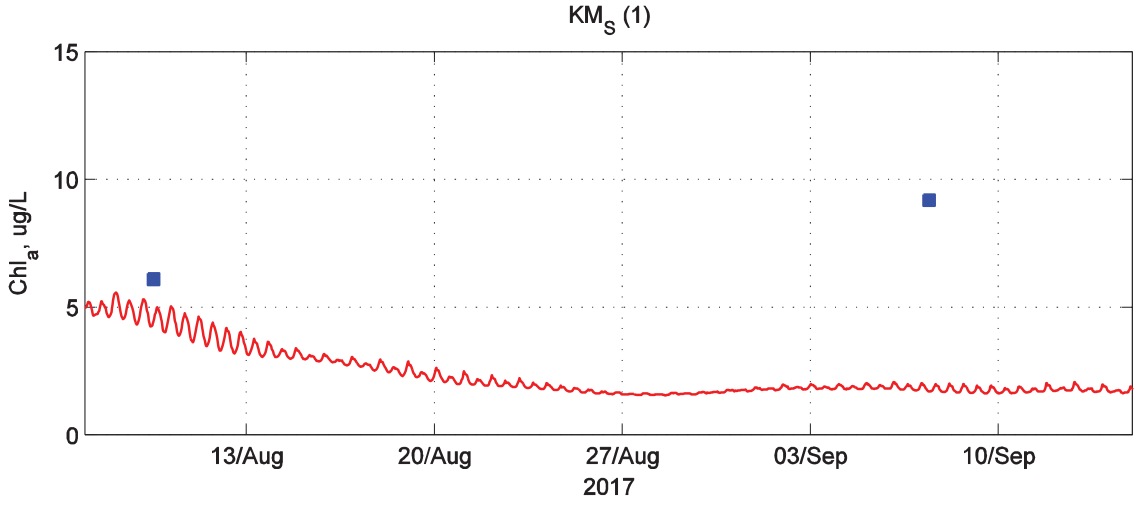

M35 (1)

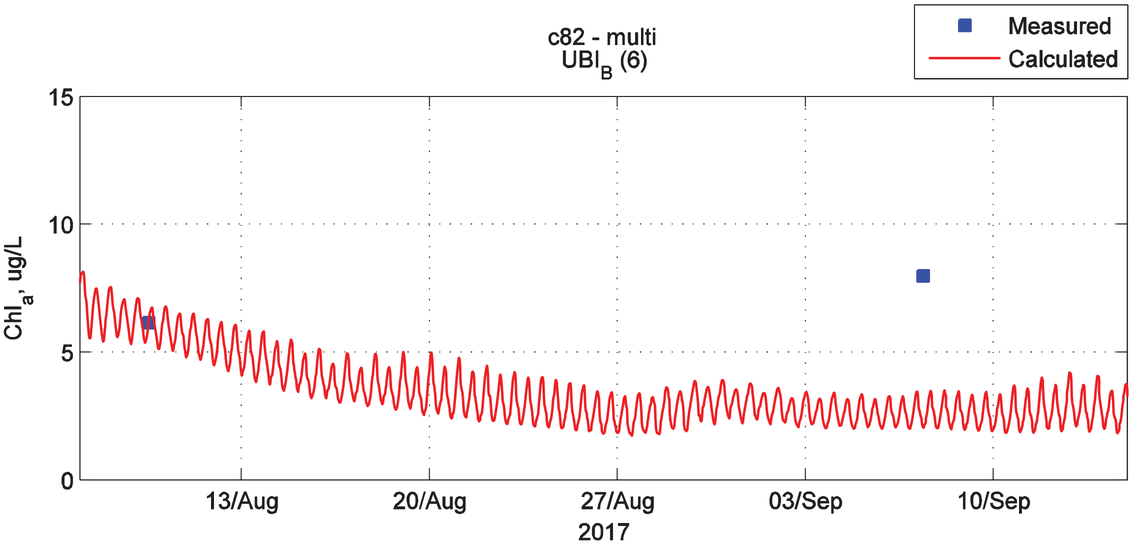

■ Measured
Calculated
c82 - multi
M23 (1)
15
10
5
0
Chl$_a$, ug/L
Jul
Aug
Sep
Oct
Nov
2017
M18 (1)
15
10
5
0
Chl$_a$, ug/L
Jul
Aug
Sep
Oct
Nov
2017

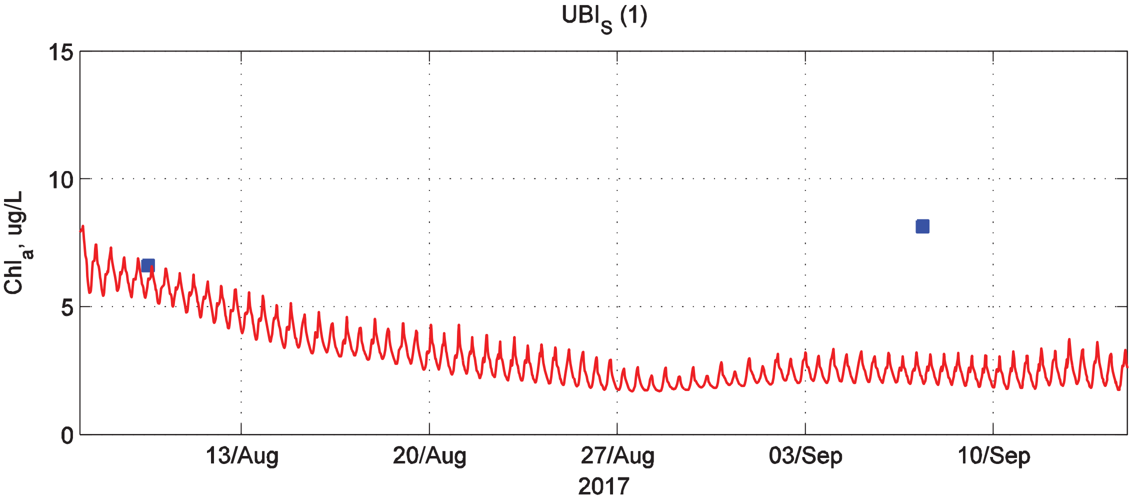

c82 - multi
NECF$_B$ (3)
Measured
Calculated
Chl$_a$, ug/L
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF$_S$ (1)
Chl$_a$, ug/L
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW$_B$ (7)
Chl$_a$, ug/L
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

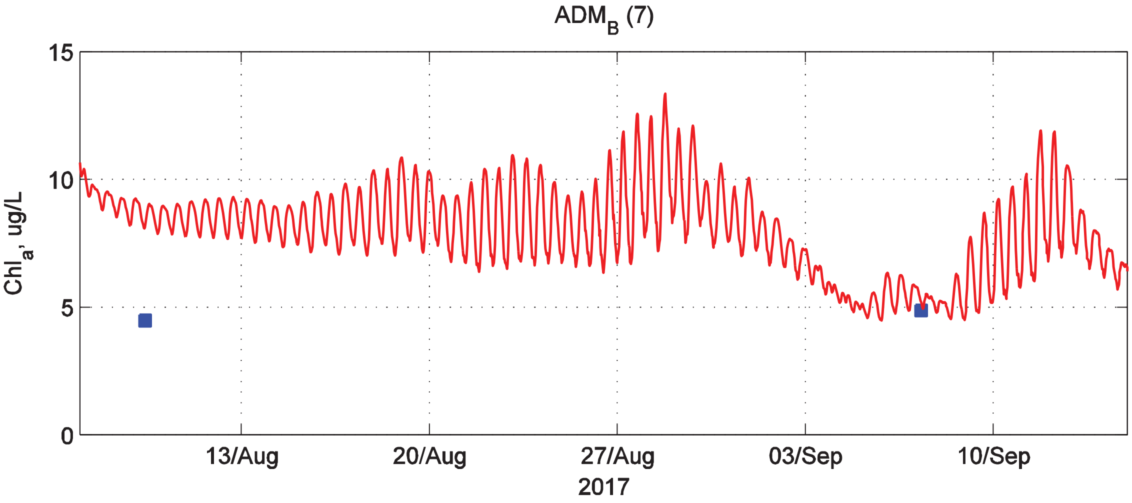

c82 - multi
CFBW$_S$ (1)
Measured
Calculated
Chl$_a$, ug/L
0
5
10
15
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

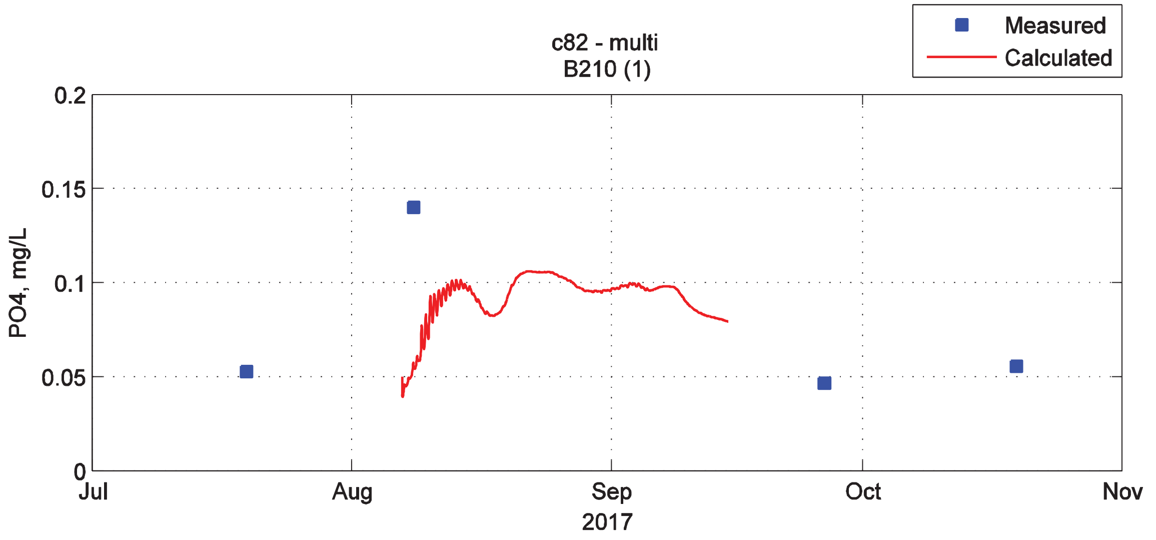

KM$_B$ (7)
Chl$_a$, ug/L
0
5
10
15
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

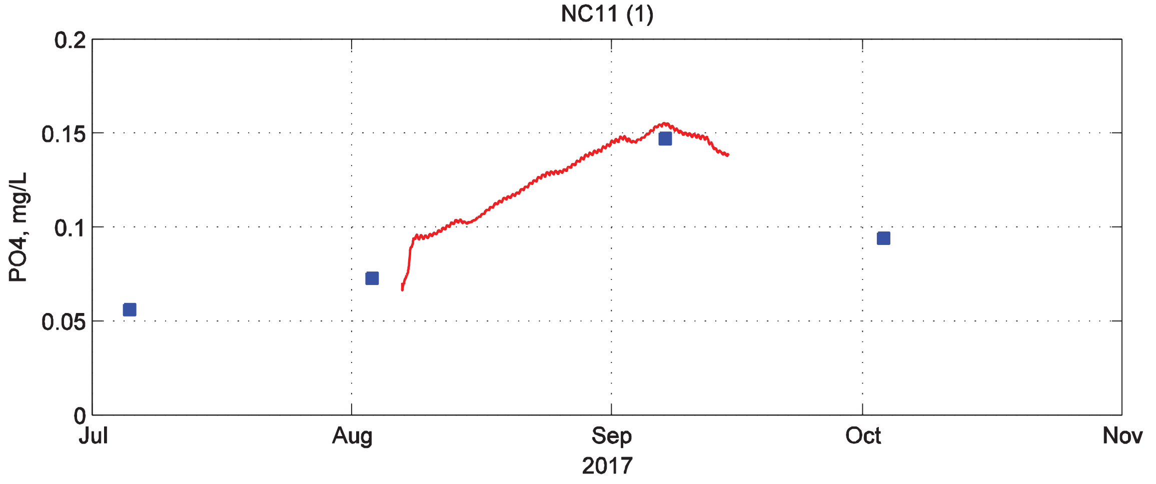

KM$_S$ (1)
Chl$_a$, ug/L
0
5
10
15
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

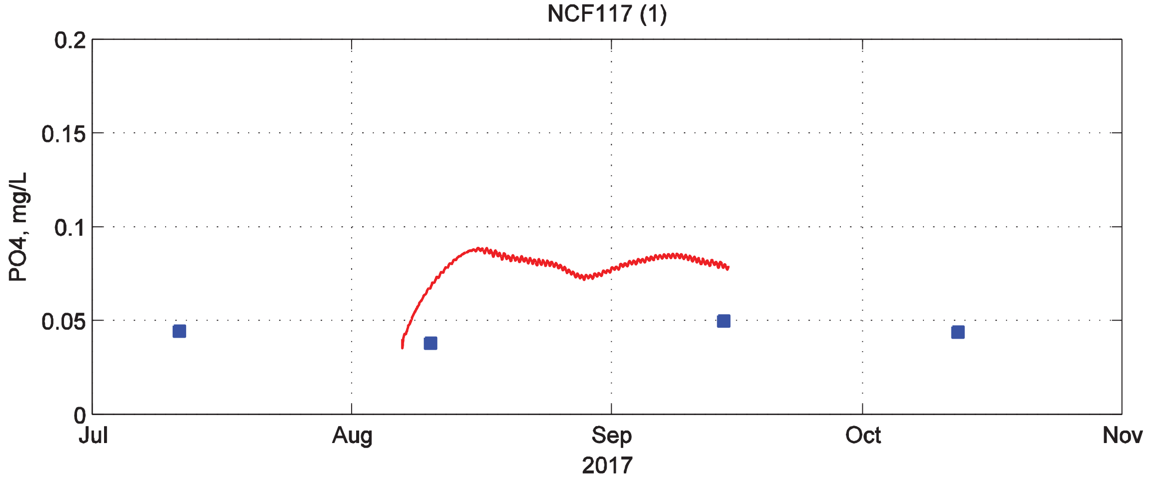

c82 - multi
UBI$_B$ (6)

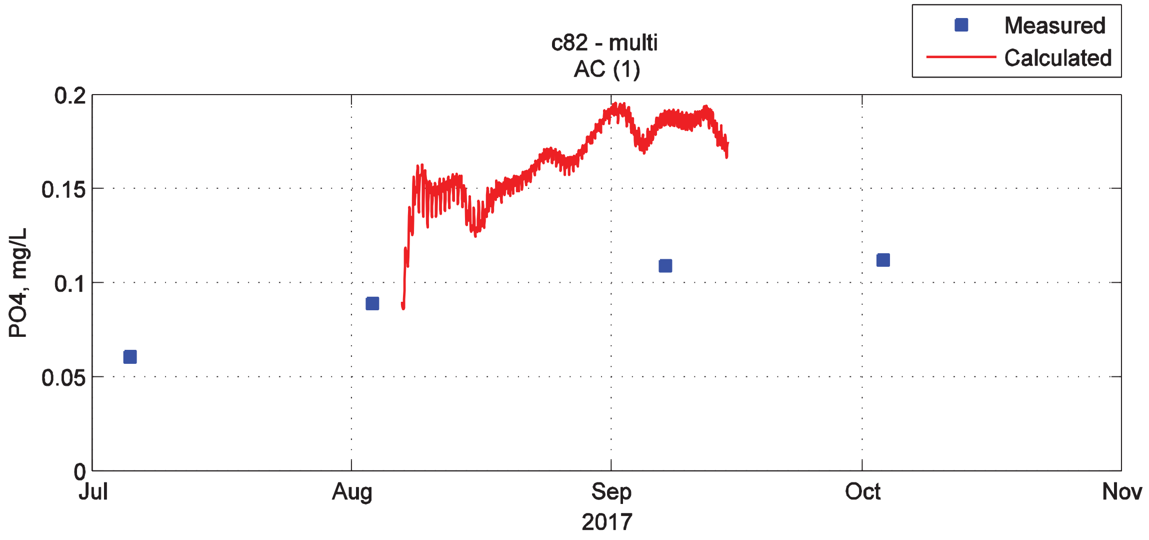

UBI$_S$ (1)

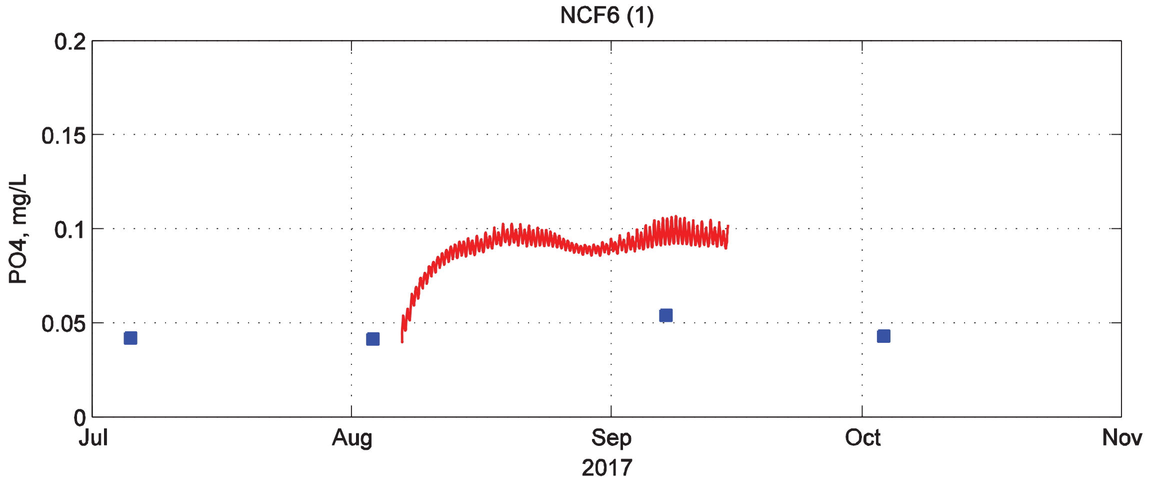

ADM$_B$ (7)

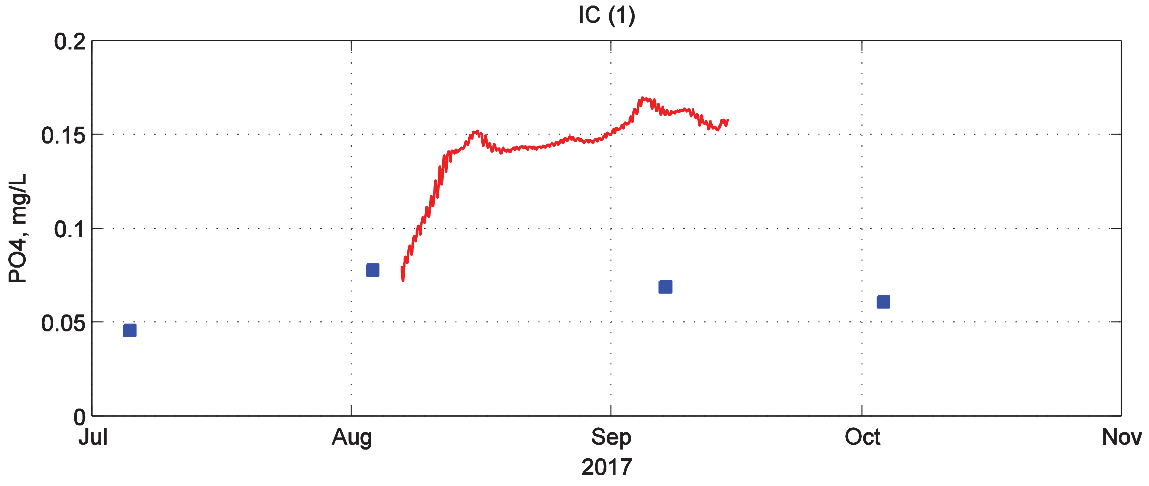

c82 - multi
B210 (1)
Measured
Calculated
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

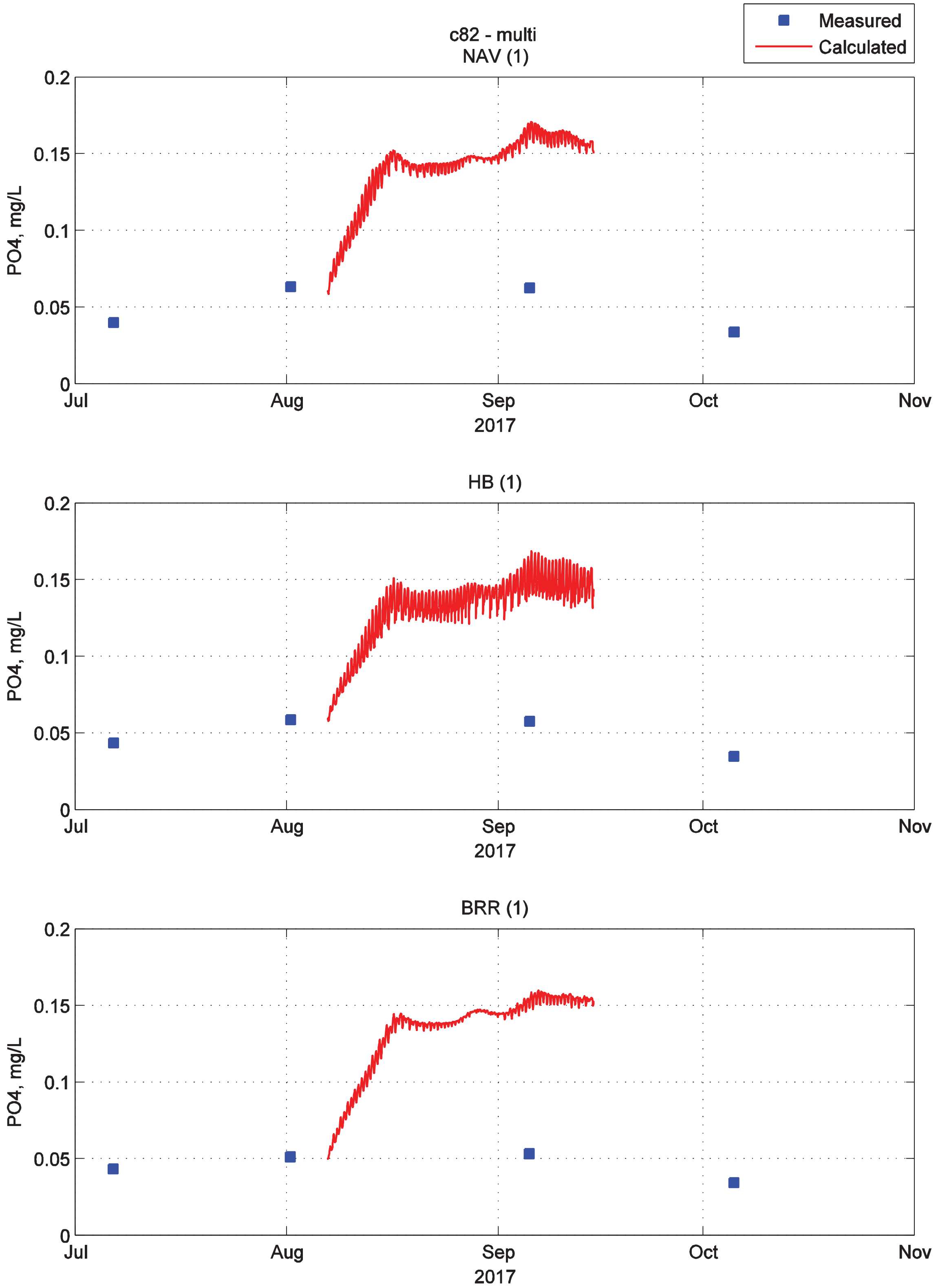

NC11 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

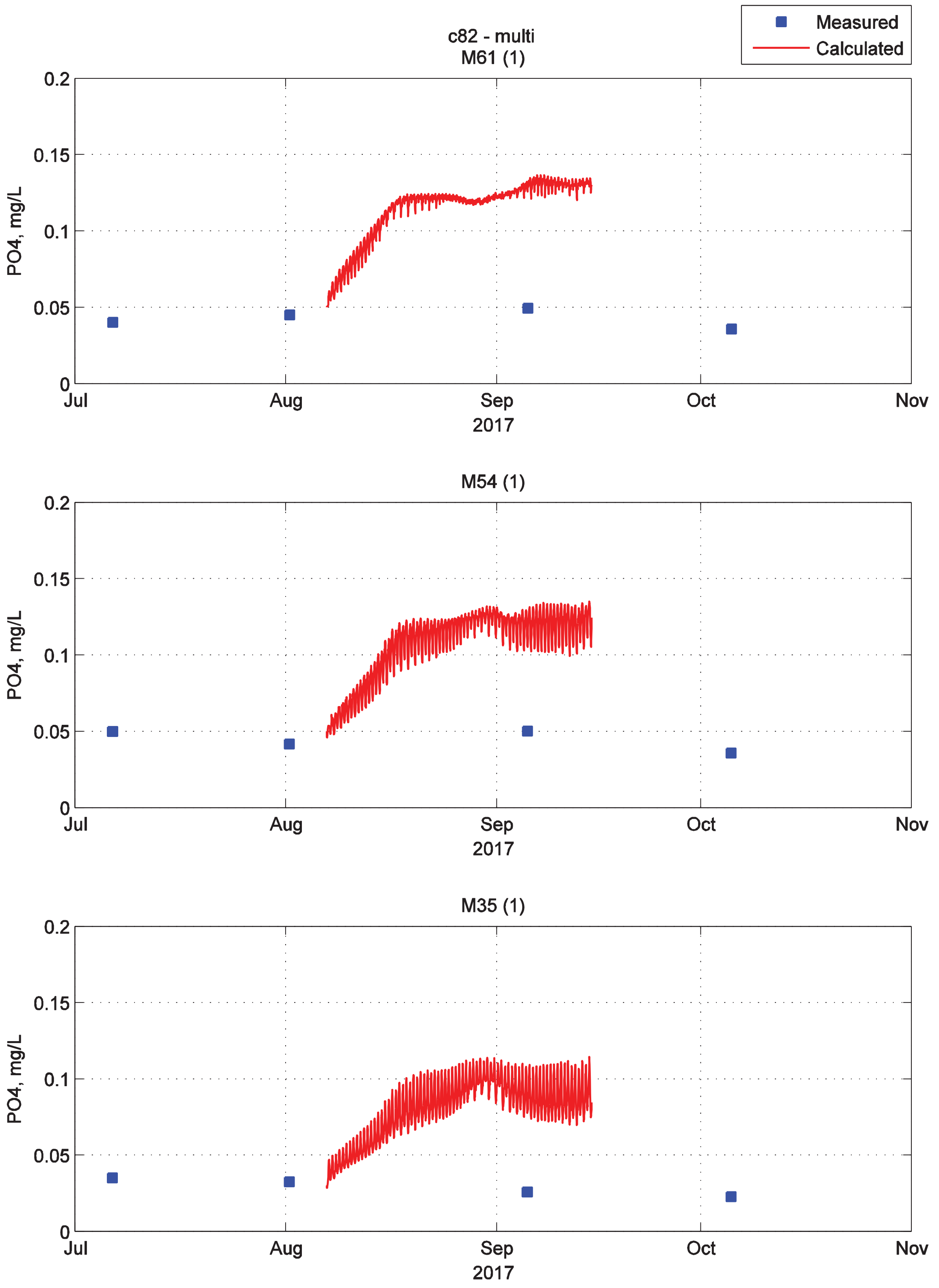

NCF117 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

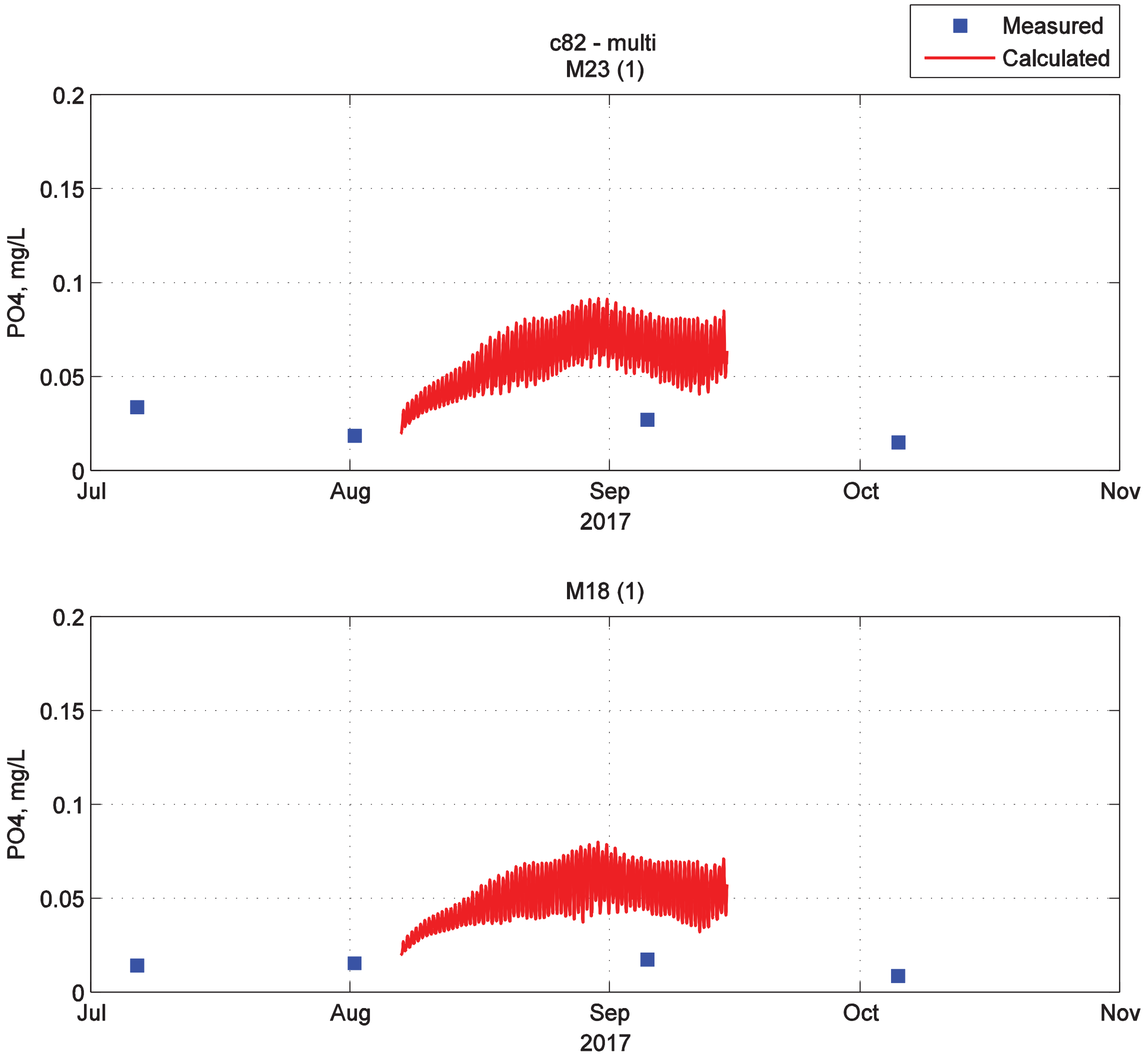

c82 - multi
AC (1)

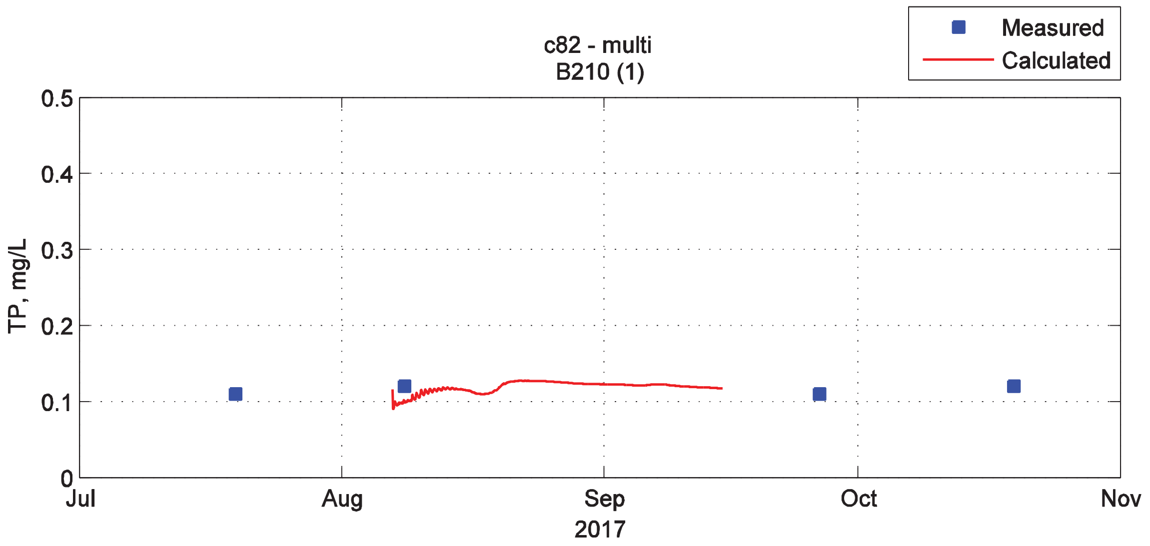

NCF6 (1)

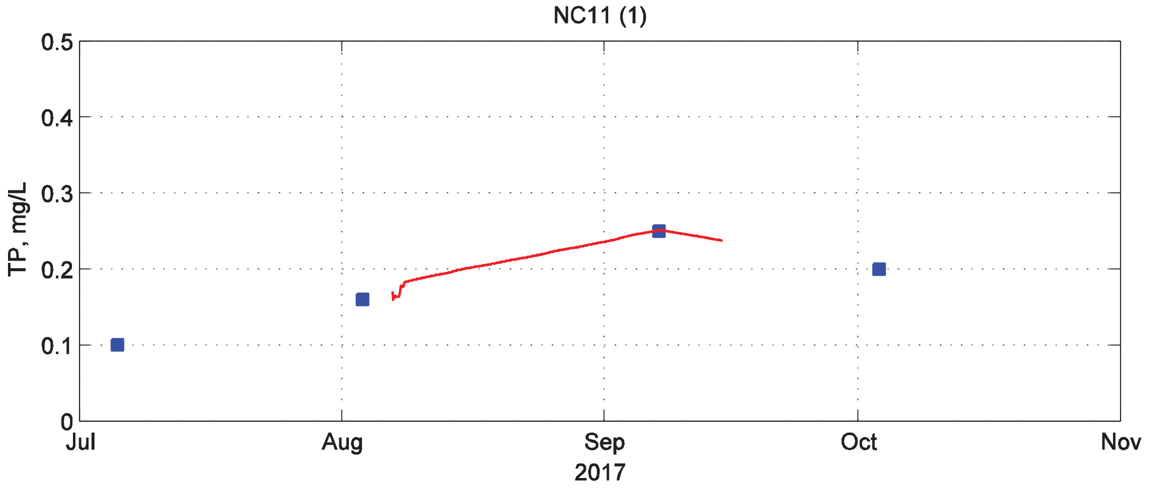

IC (1)

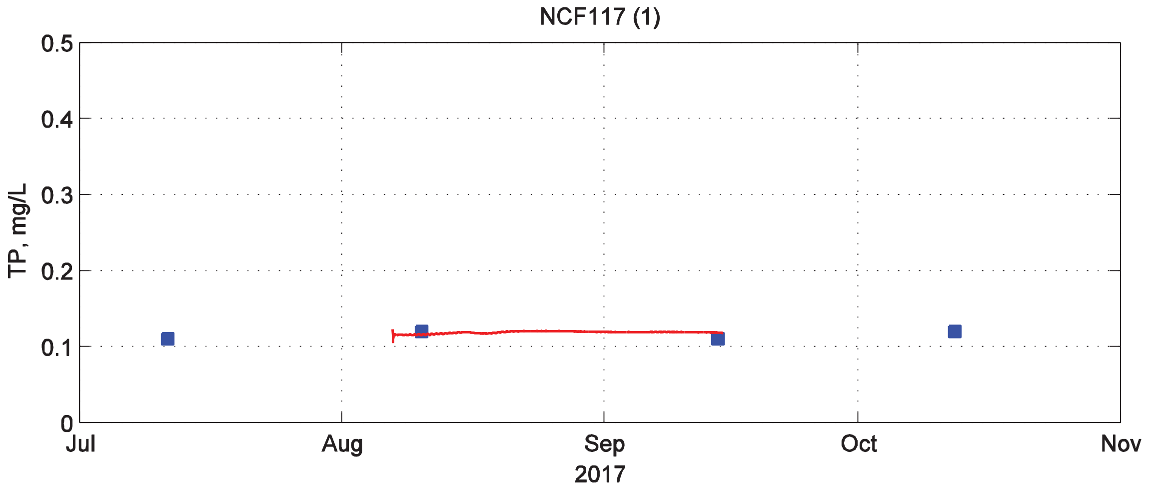

■ Measured
— Calculated
c82 - multi
NAV (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
HB (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
BRR (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

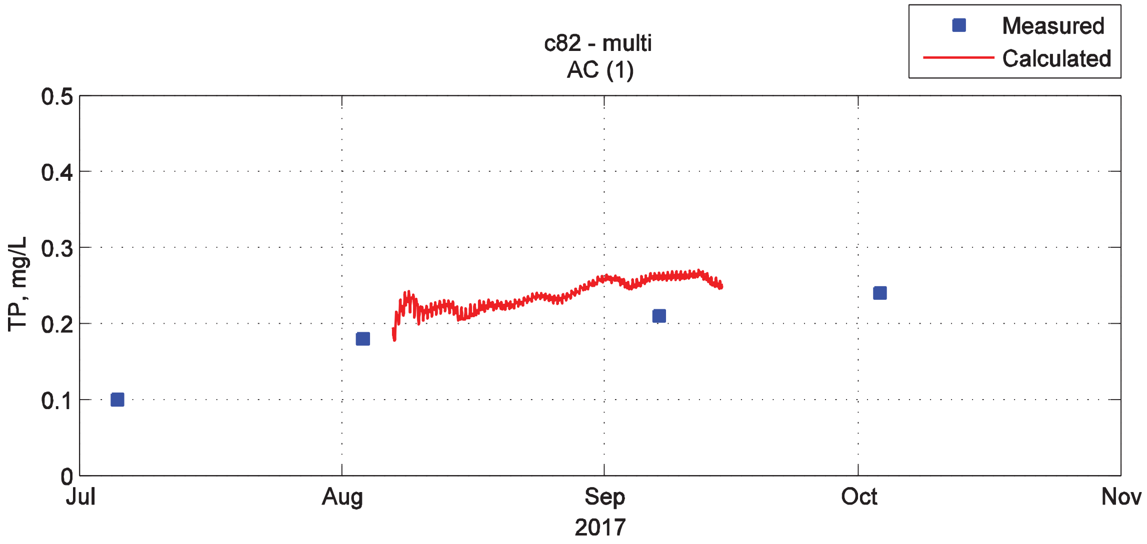

■ Measured
— Calculated
c82 - multi
M61 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
M54 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
M35 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

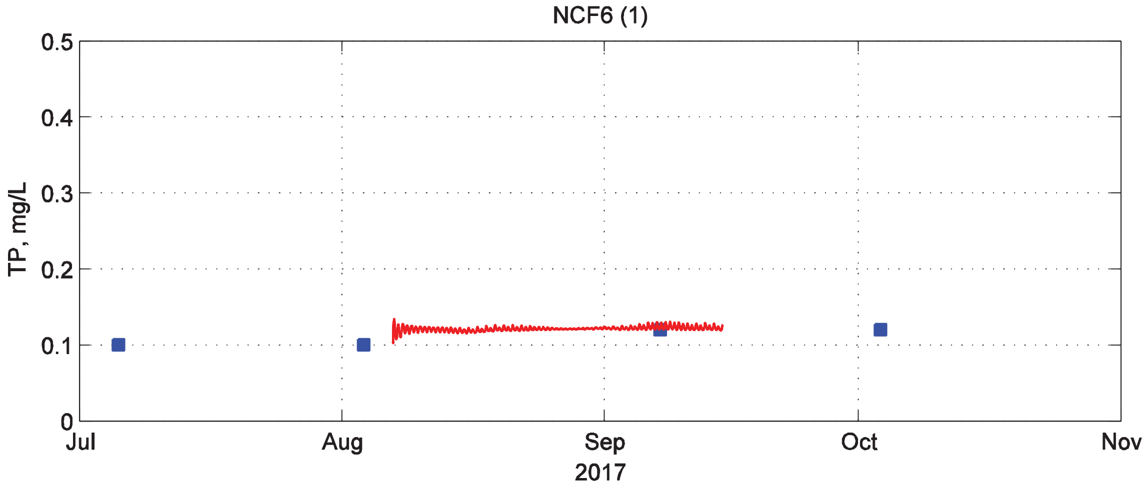

■ Measured
Calculated
c82 - multi
M23 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
M18 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

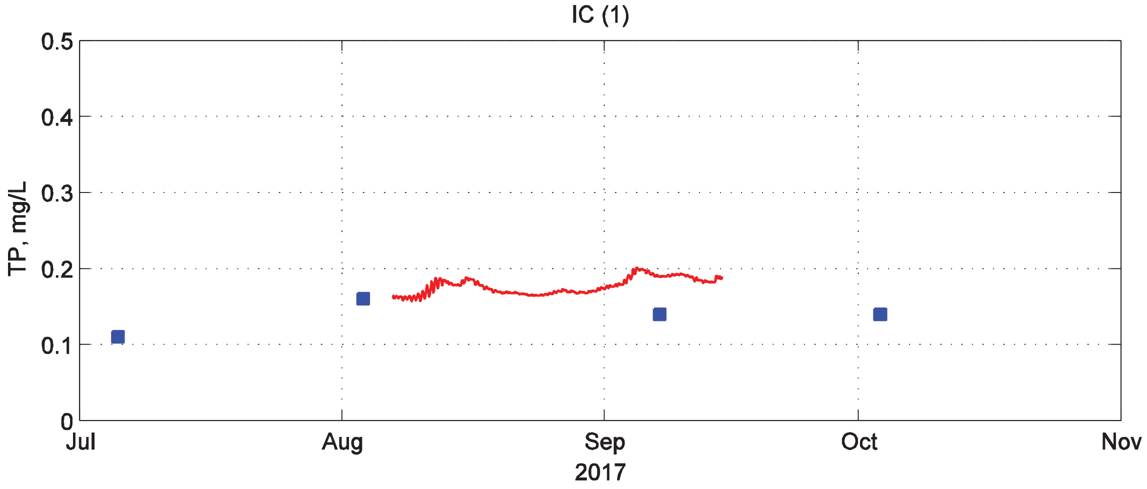

c82 - multi
B210 (1)

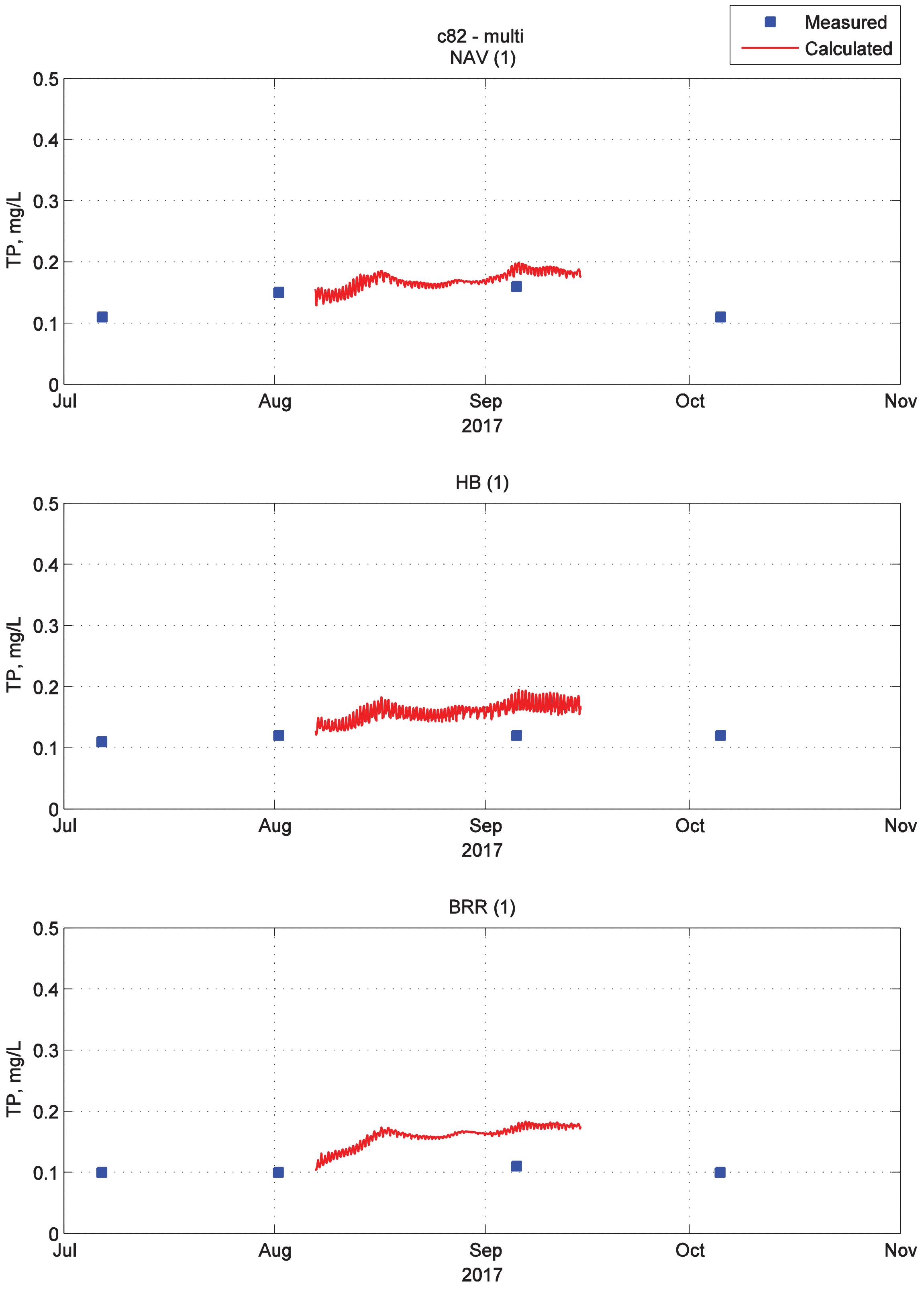

NC11 (1)

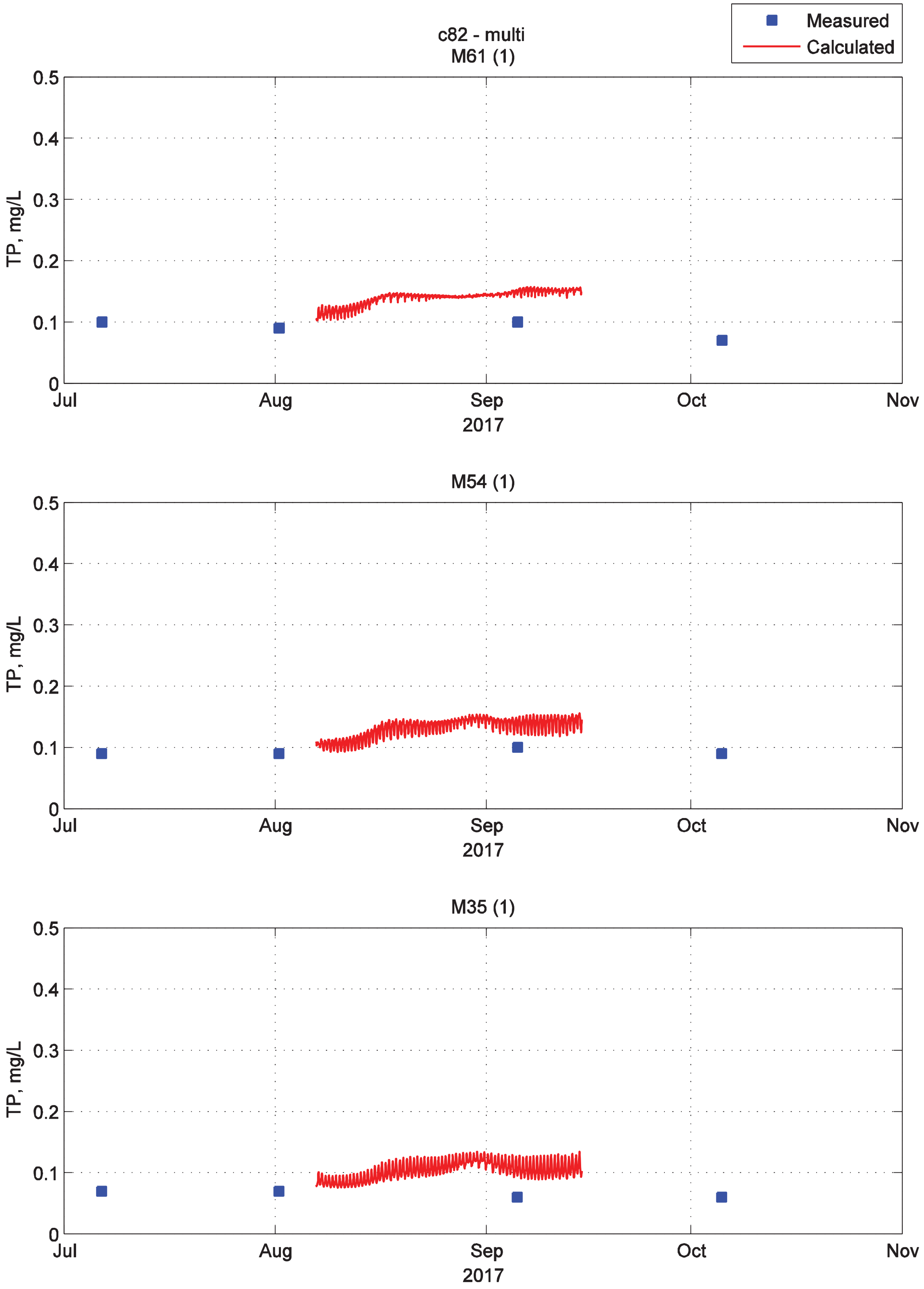

NCF117 (1)

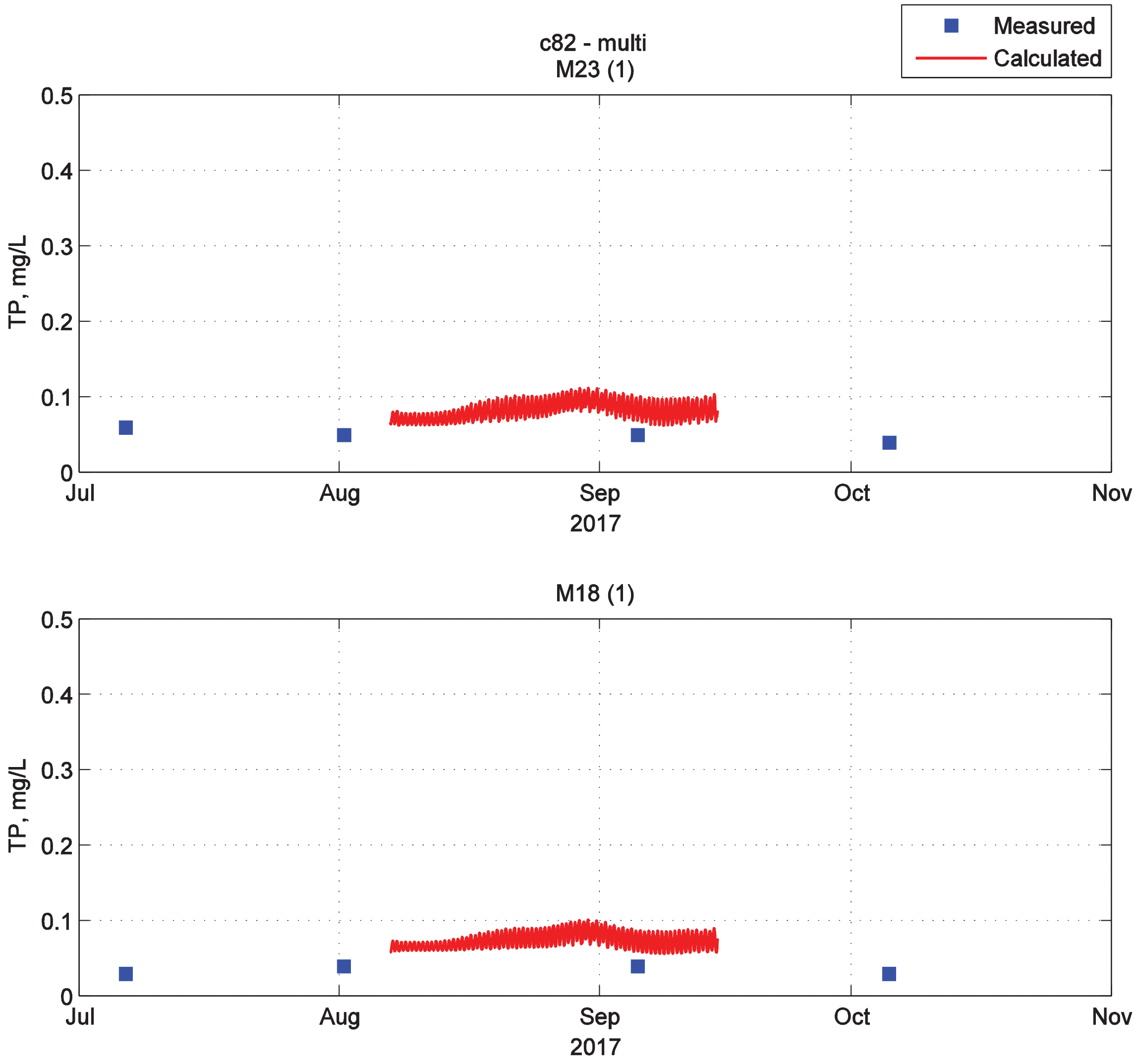

c82 - multi
AC (1)

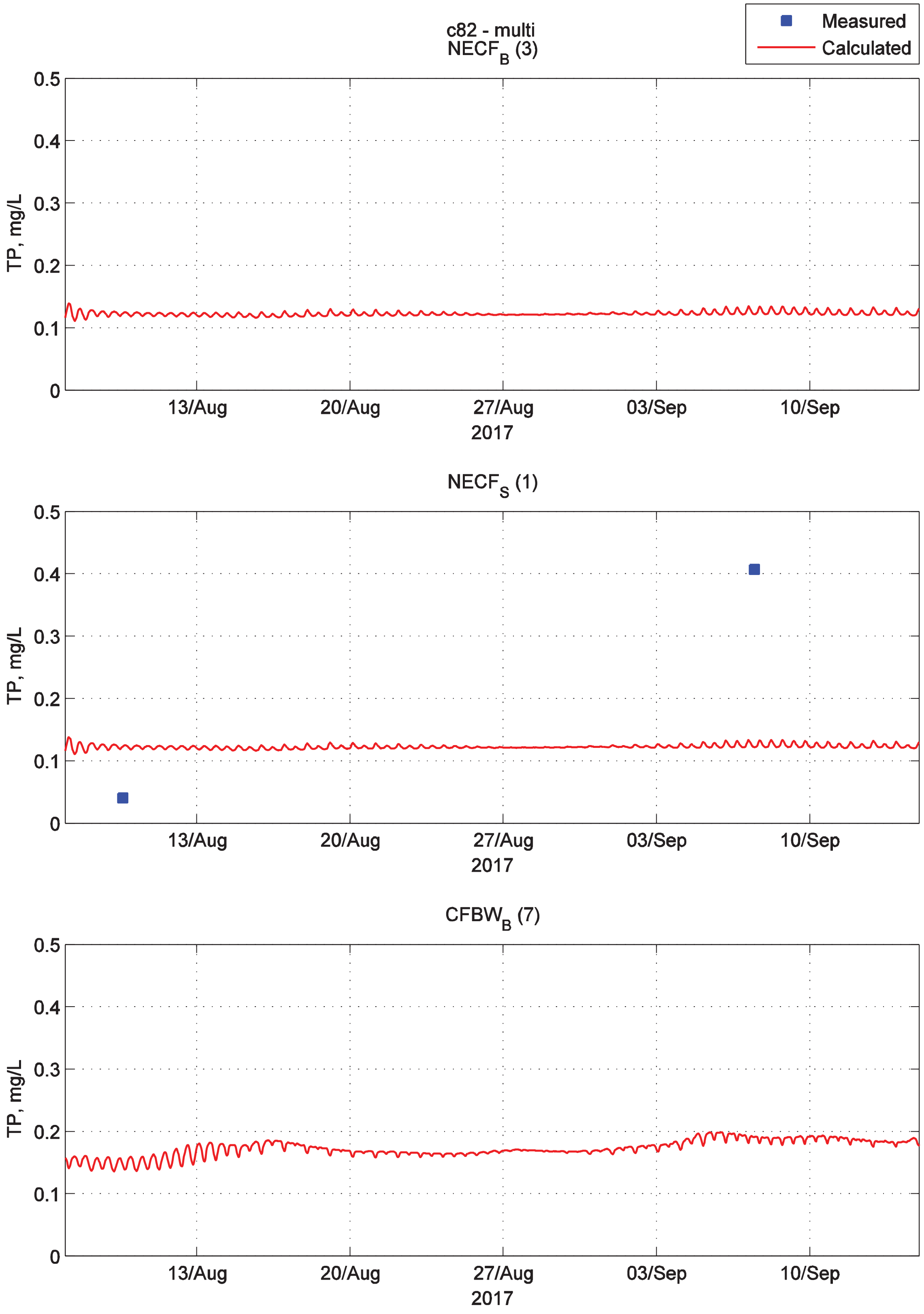

NCF6 (1)


IC (1)


Measured
Calculated
c82 - multi
NAV (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
Jul
Aug
Sep
Oct
Nov
2017
HB (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
Jul
Aug
Sep
Oct
Nov
2017
BRR (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
Jul
Aug
Sep
Oct
Nov
2017


■ Measured
Calculated
c82 - multi
M61 (1)
TP, mg/L
0
0.1
0.2
0.3
0.4
0.5
Jul
Aug
Sep
Oct
Nov
2017
M54 (1)
TP, mg/L
0
0.1
0.2
0.3
0.4
0.5
Jul
Aug
Sep
Oct
Nov
2017
M35 (1)
TP, mg/L
0
0.1
0.2
0.3
0.4
0.5
Jul
Aug
Sep
Oct
Nov
2017


Measured
Calculated
c82 - multi
M23 (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
Jul
Aug
Sep
Oct
Nov
2017
M18 (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
Jul
Aug
Sep
Oct
Nov
2017

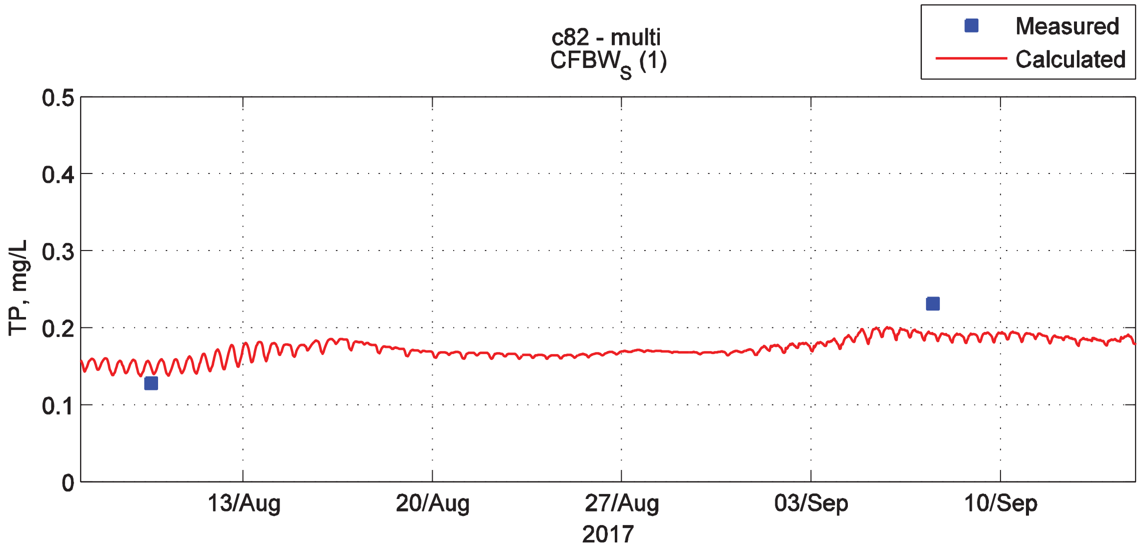


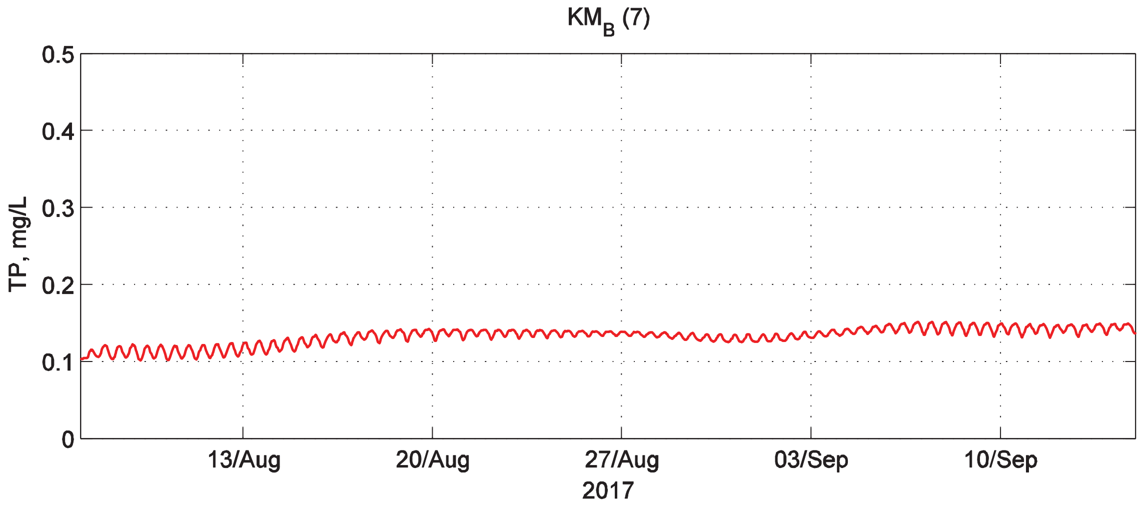
c82 - multi

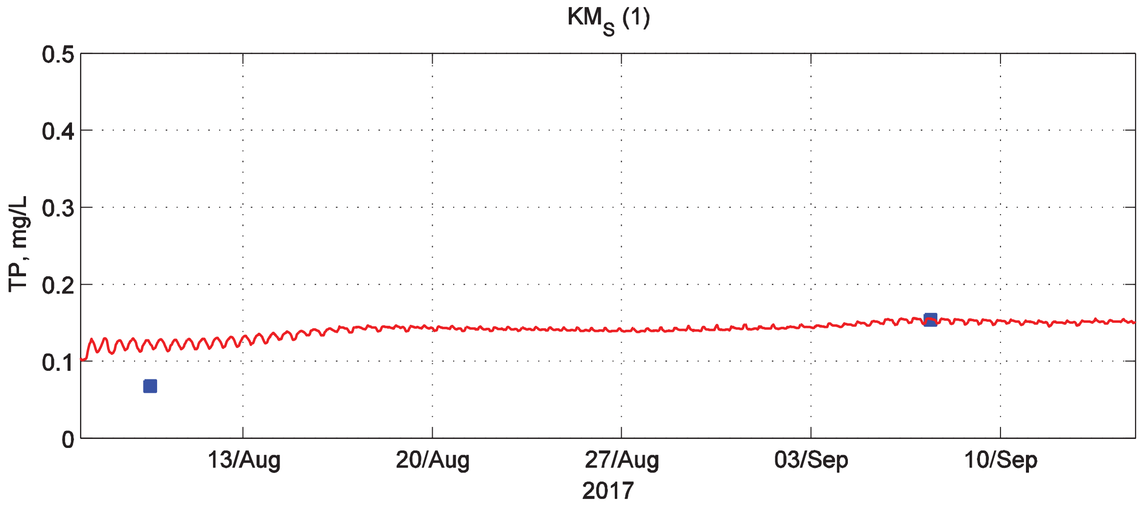
NECF$_B$ (3)

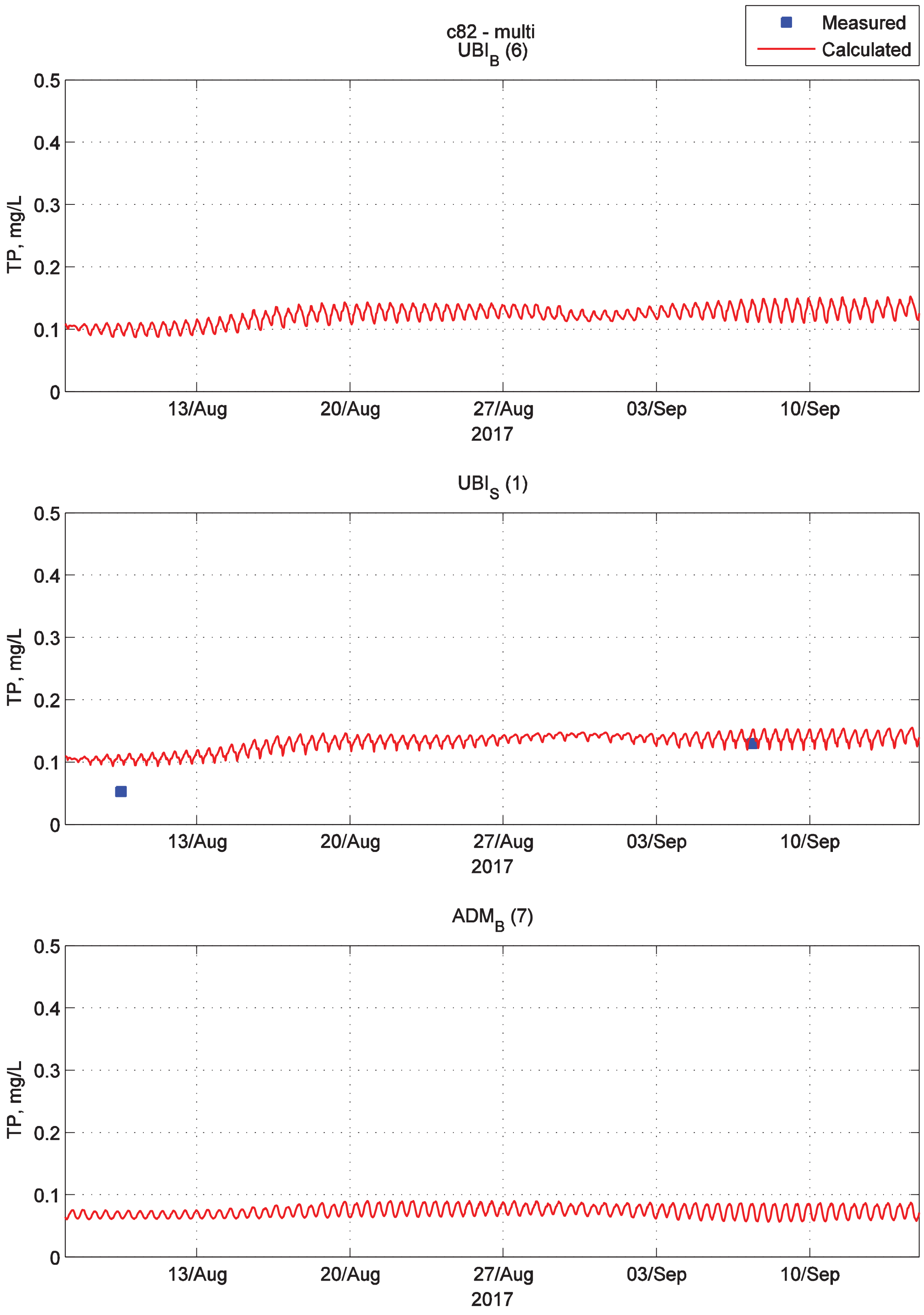
NECF$_S$ (1)

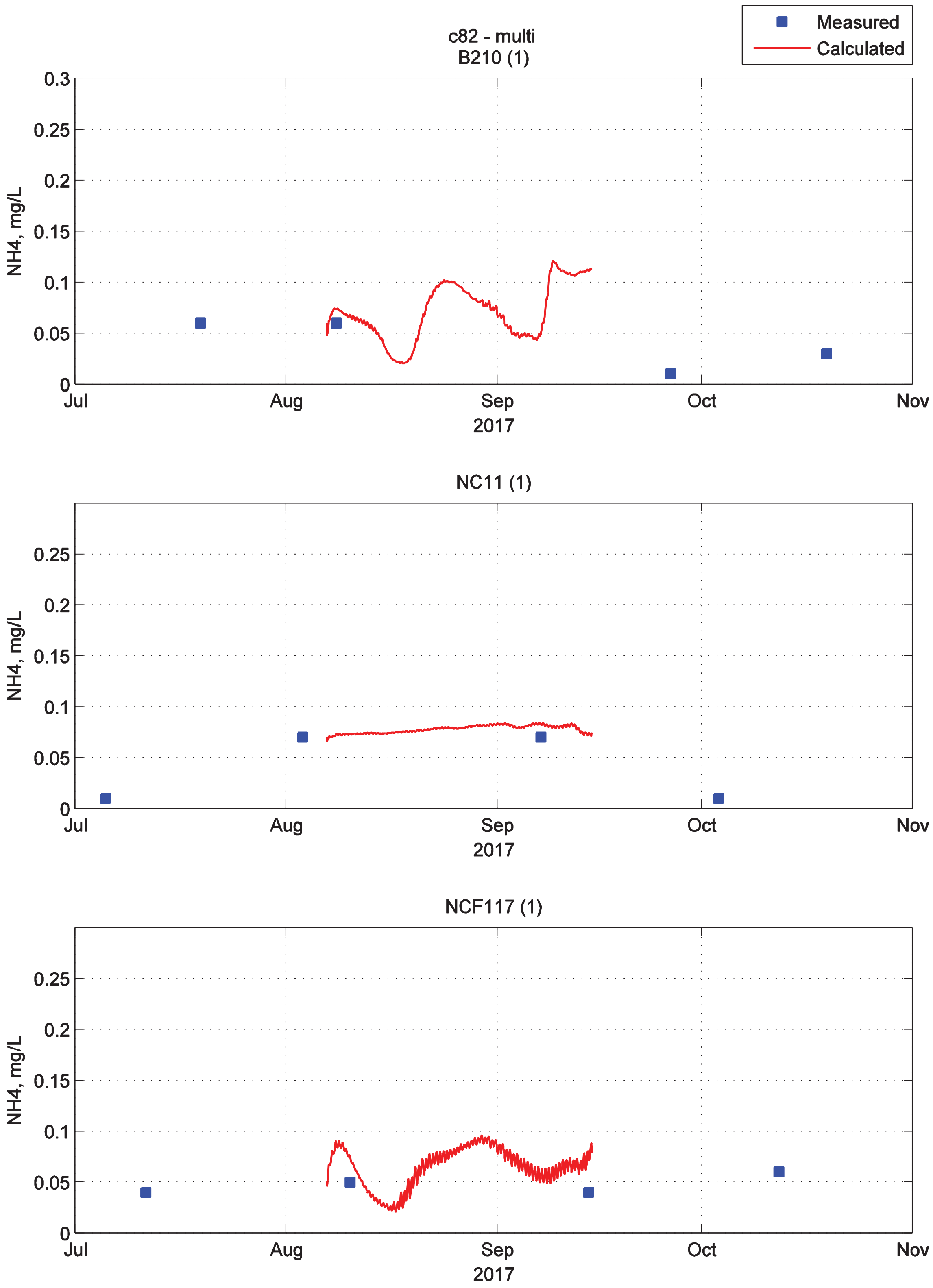
CFBW$_B$ (7)

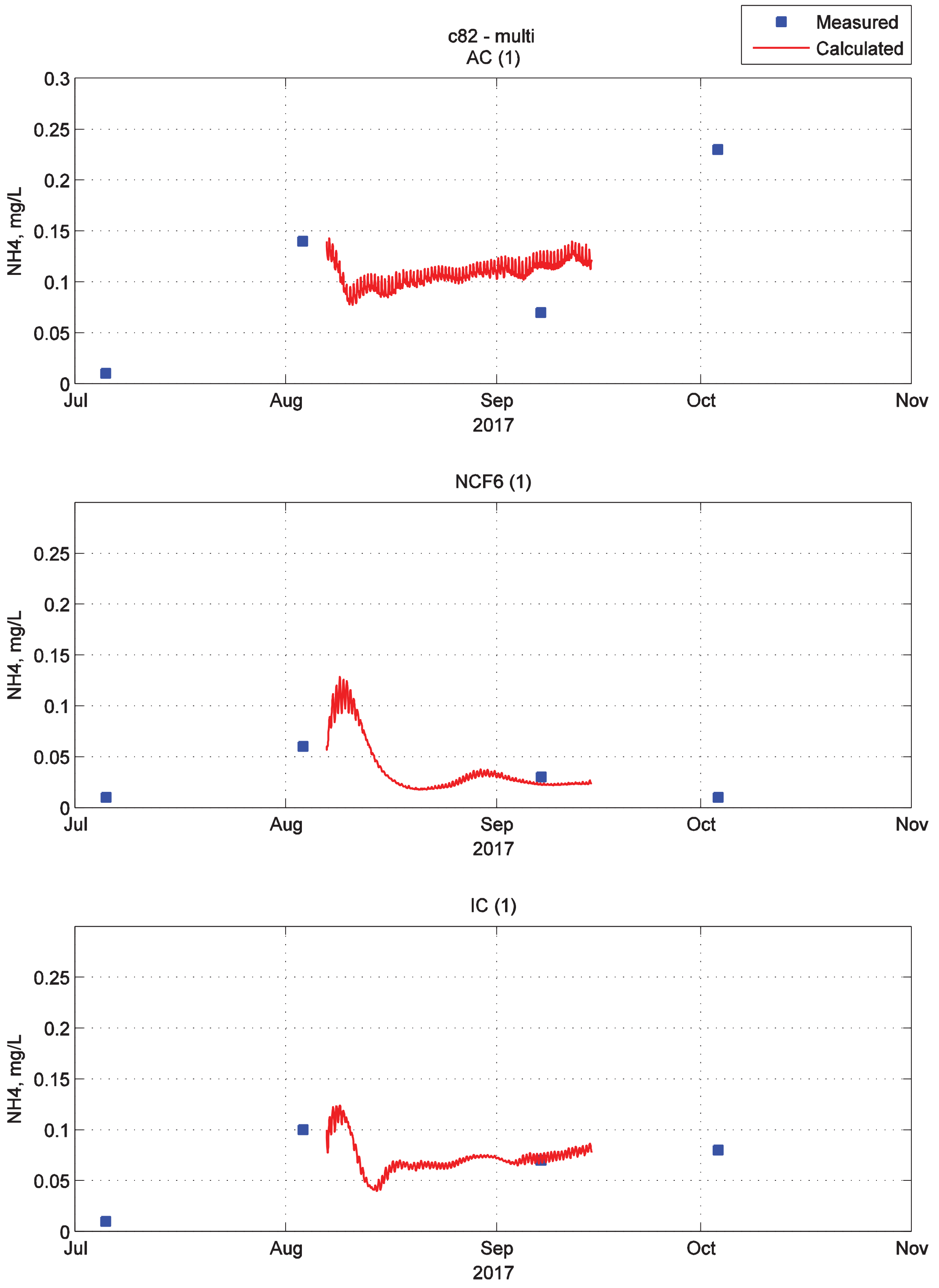

c82 - multi
CFBW$_S$ (1)
Measured
Calculated
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

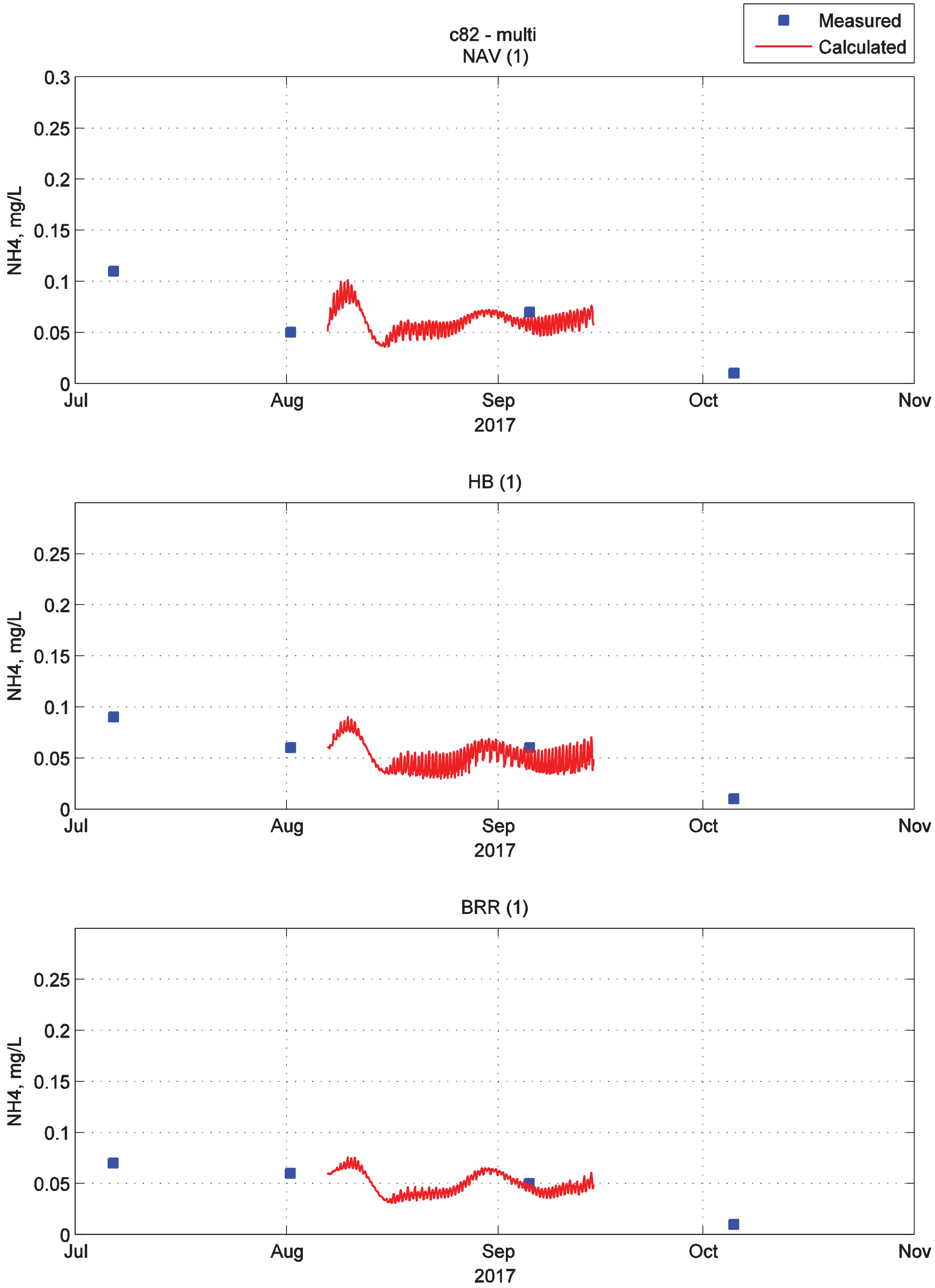

KM$_B$ (7)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

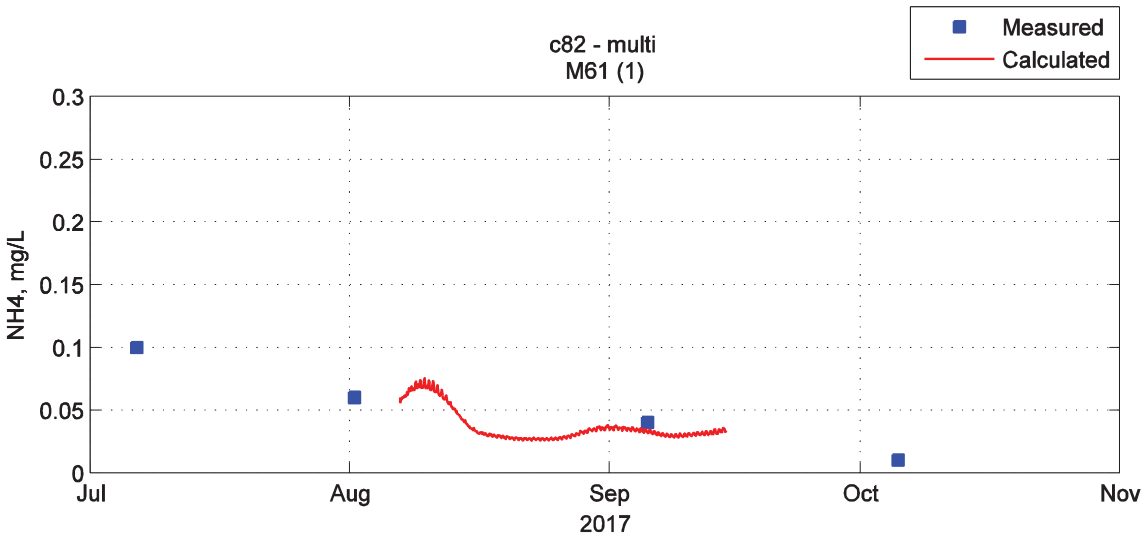

KM$_S$ (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

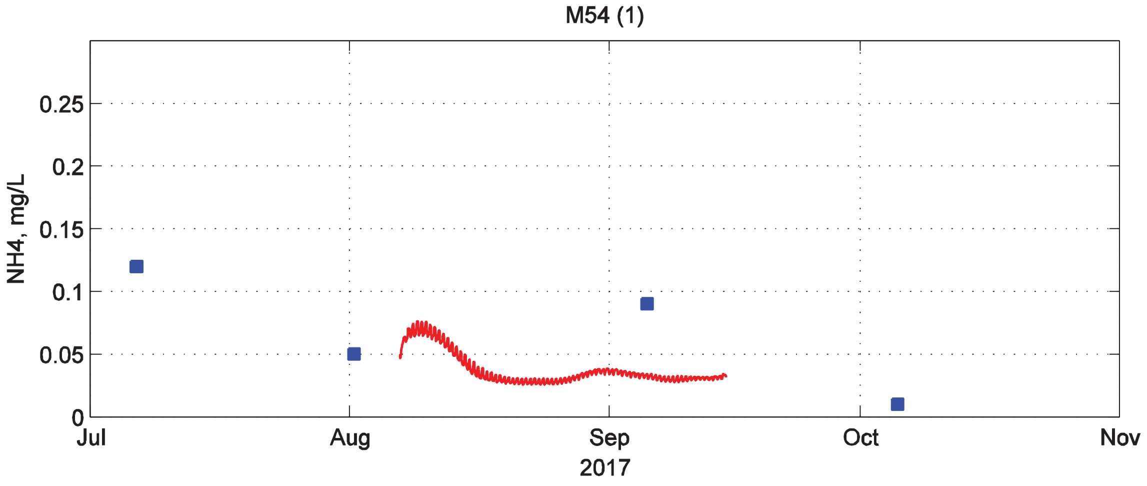

c82 - multi
UBI$_B$ (6)
■ Measured
Calculated
TP, mg/L
0
0.1
0.2
0.3
0.4
0.5
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI$_S$ (1)
ADM$_B$ (7)

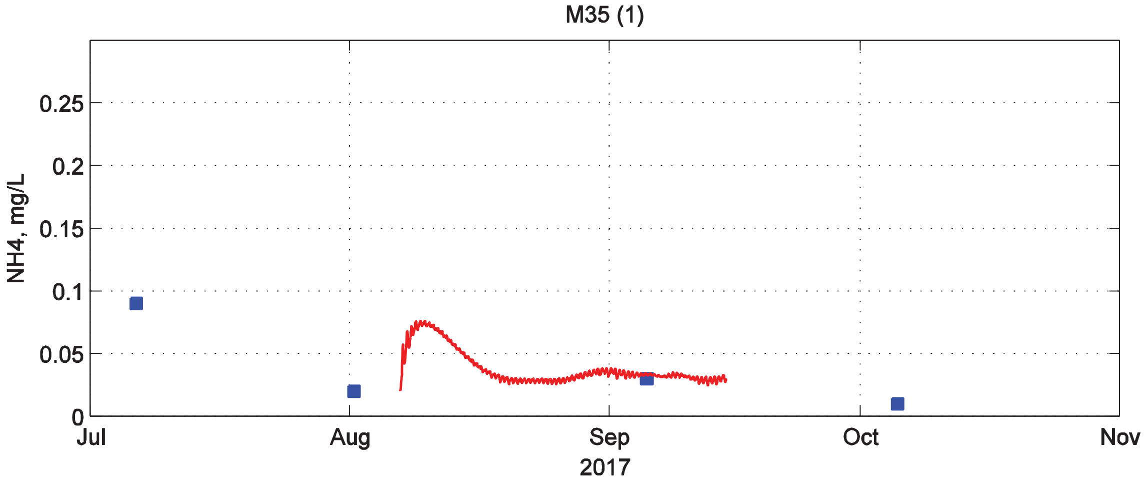

Measured
Calculated
c82 - multi
B210 (1)
NH4, mg/L
0
0.05
0.1
0.15
0.2
0.25
0.3
Jul
Aug
Sep
Oct
Nov
2017
NC11 (1)
NH4, mg/L
0
0.05
0.1
0.15
0.2
0.25
Jul
Aug
Sep
Oct
Nov
2017
NCF117 (1)
NH4, mg/L
0
0.05
0.1
0.15
0.2
0.25
Jul
Aug
Sep
Oct
Nov
2017

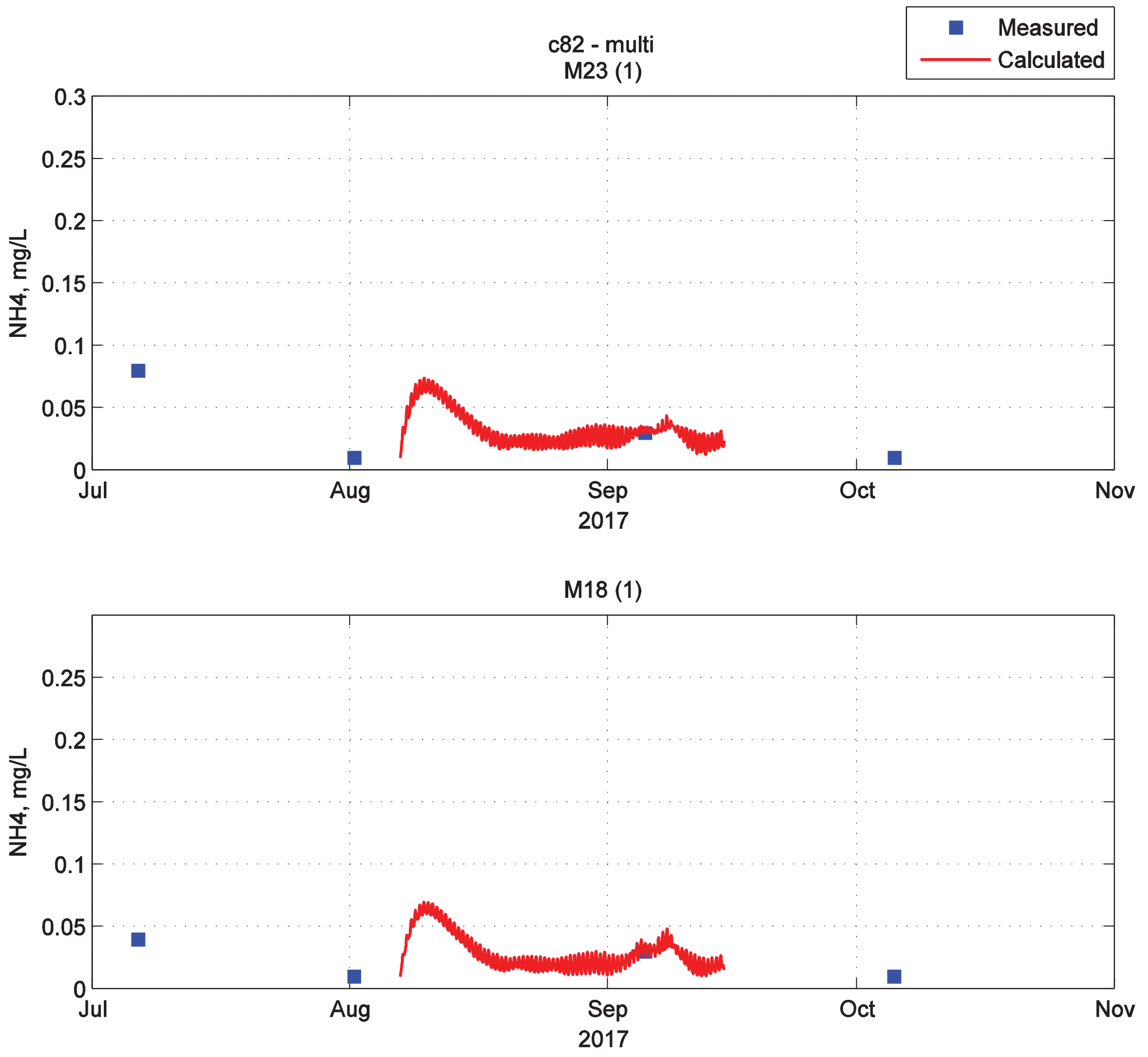

c82 - multi
AC (1)
■ Measured
Calculated
NH4, mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
NCF6 (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
IC (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

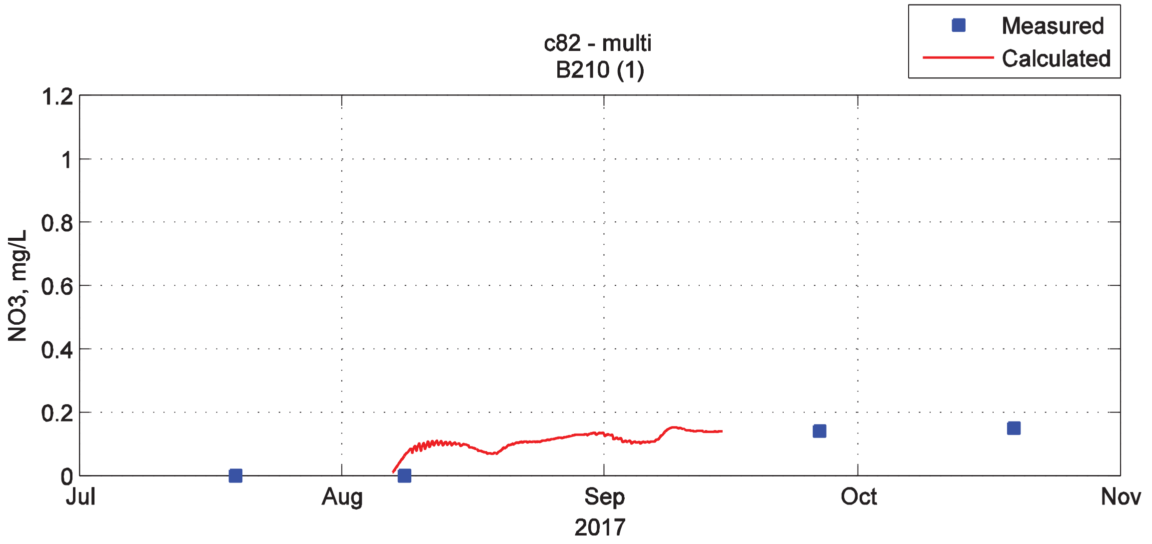

Measured
Calculated
c82 - multi
NAV (1)
HB (1)
BRR (1)
NH4, mg/L
0
0.05
0.1
0.15
0.2
0.25
0.3
Jul
Aug
Sep
Oct
Nov
2017

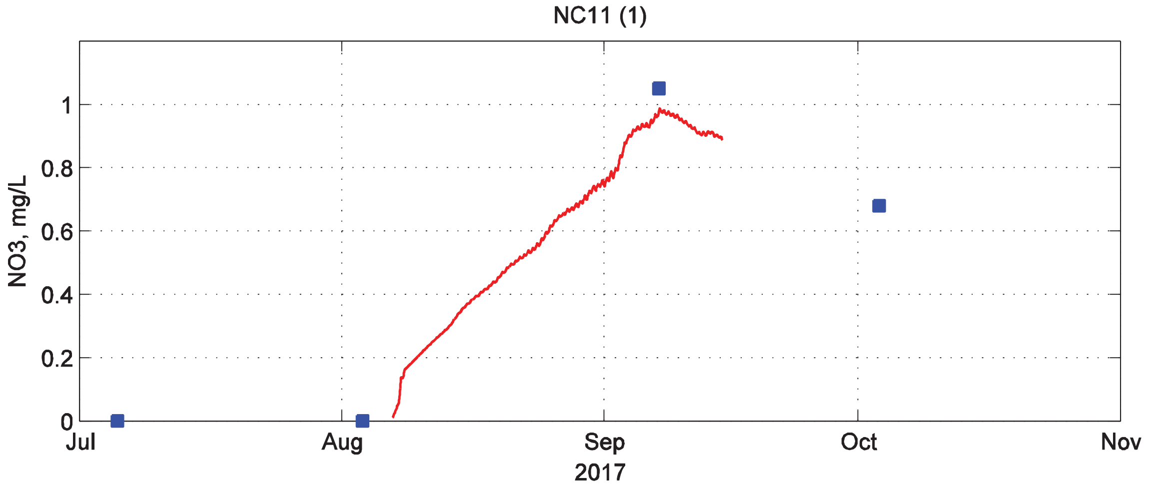

c82 - multi
M61 (1)
Measured
Calculated
NH4, mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

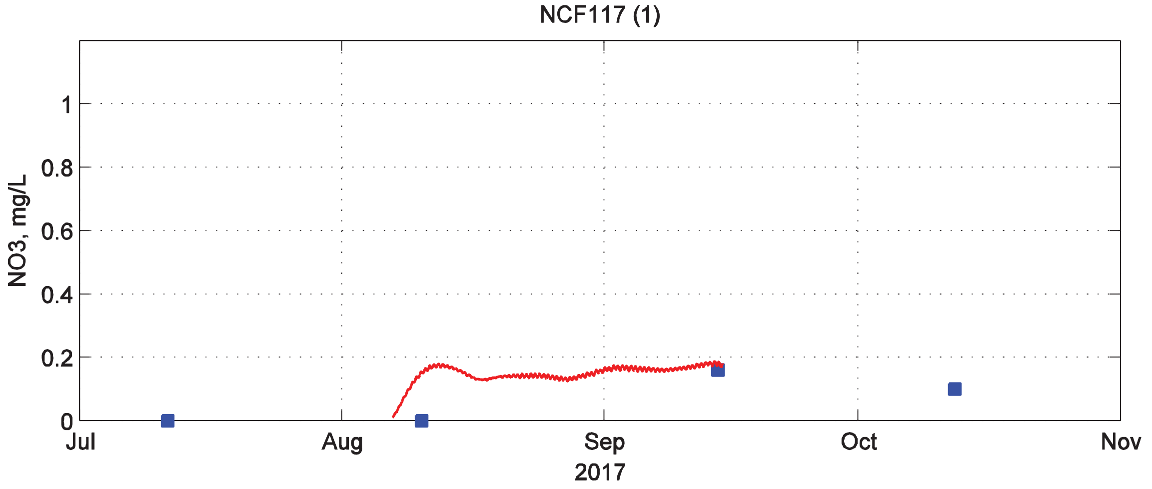

M54 (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

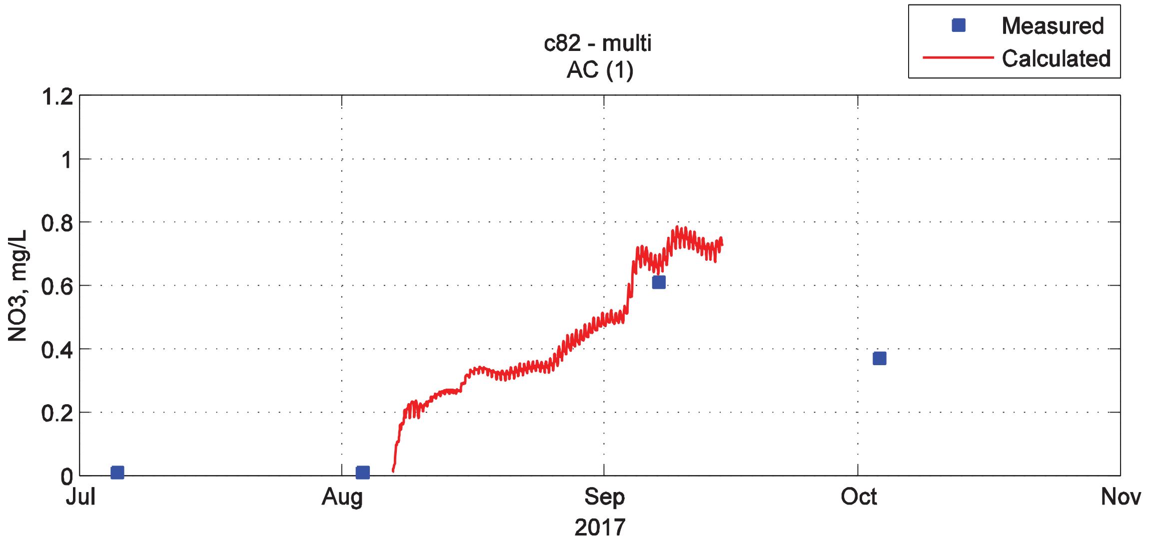

M35 (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

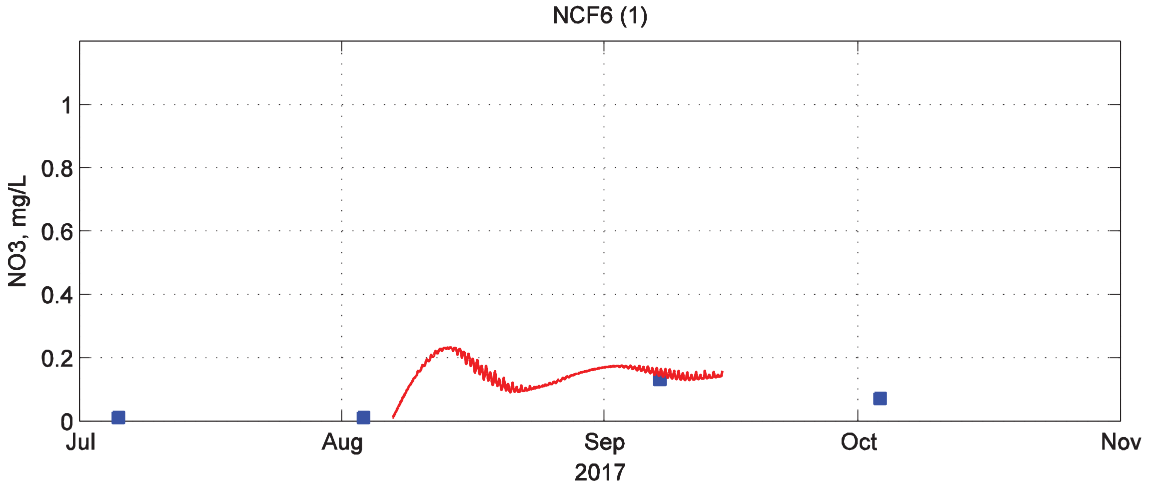

Measured
Calculated
c82 - multi
M23 (1)
NH4, mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017
M18 (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
Jul
Aug
Sep
Oct
Nov
2017

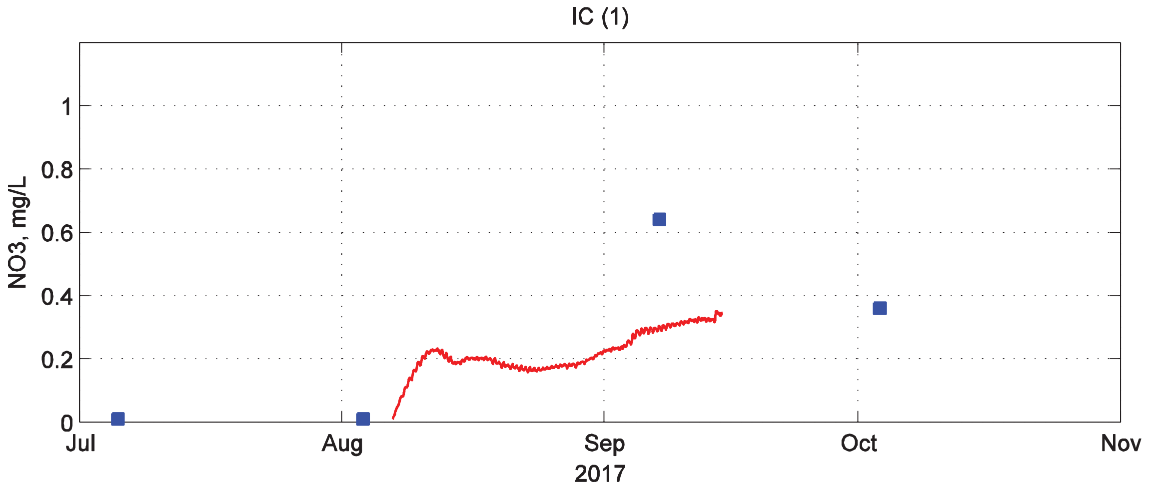

c82 - multi
B210 (1)

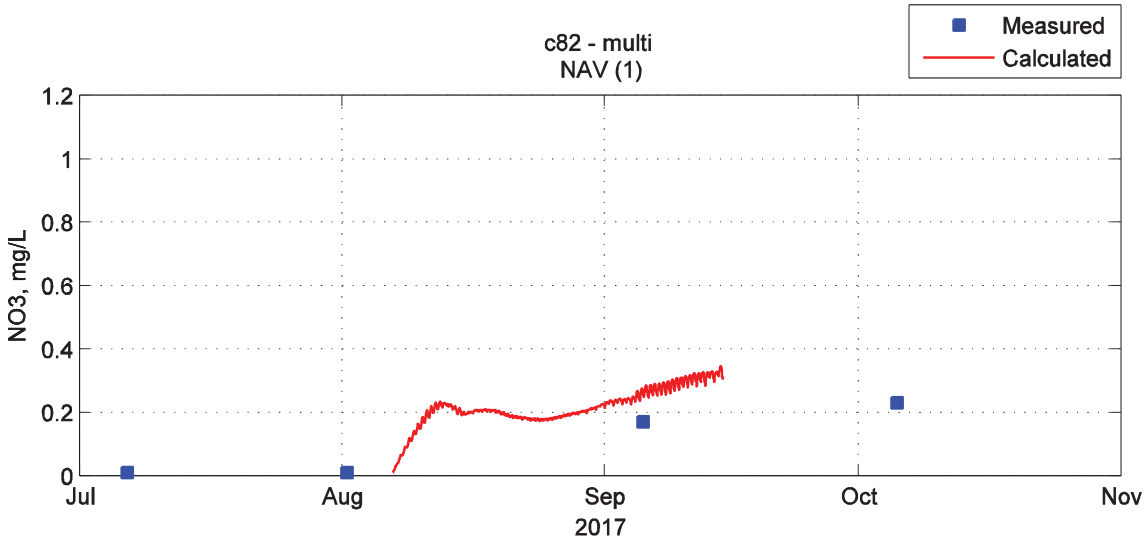

NC11 (1)

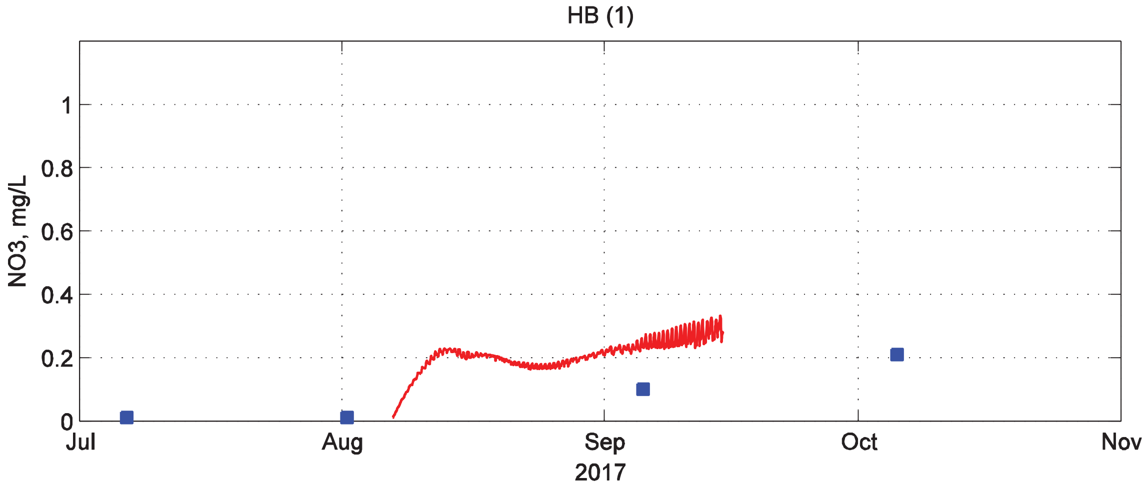

NCF117 (1)

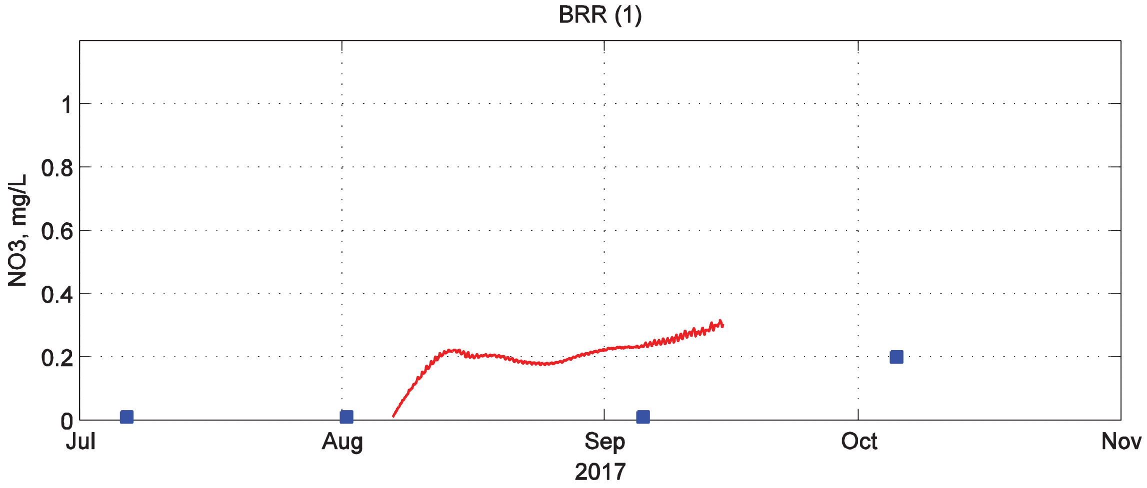

c82 - multi
AC (1)

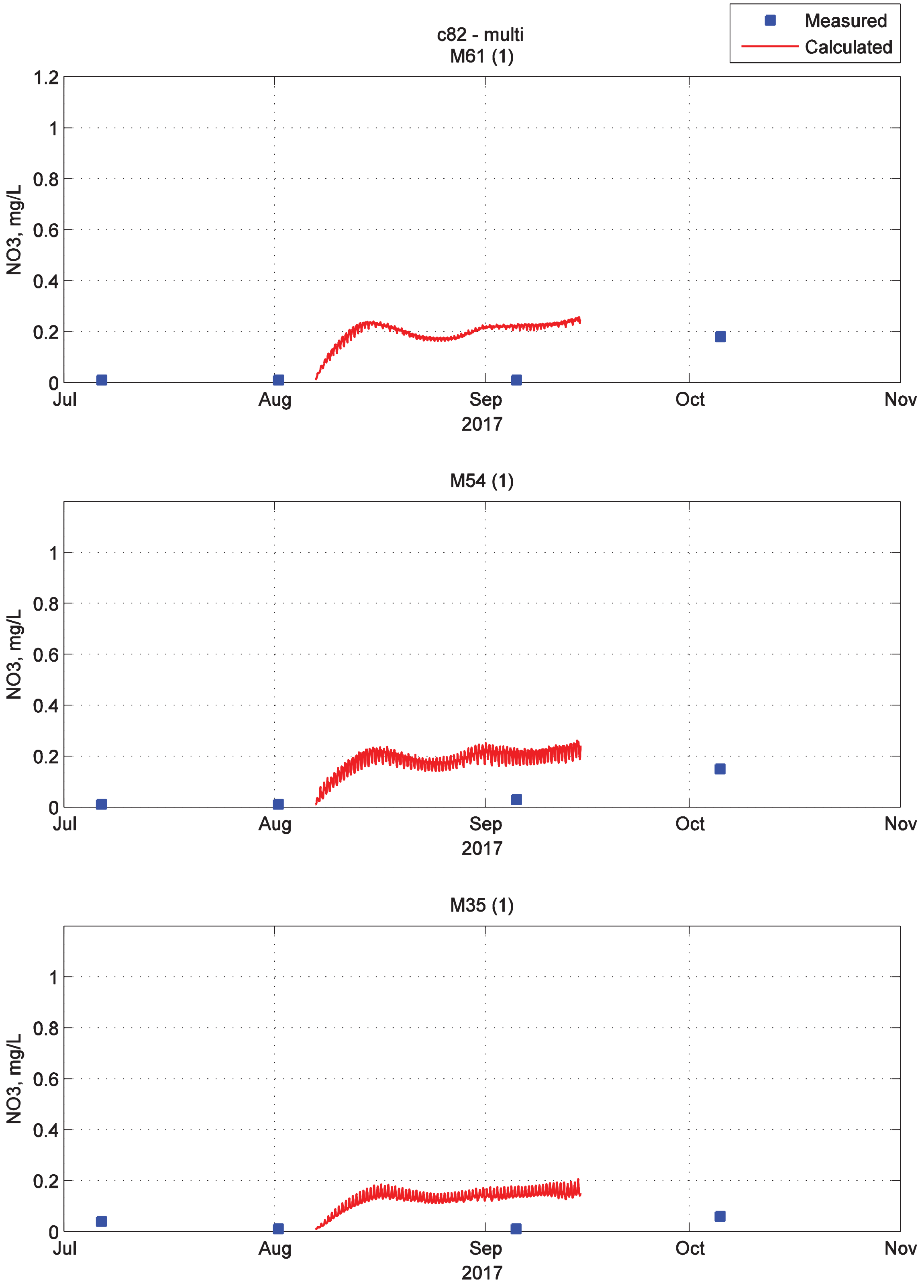

NCF6 (1)

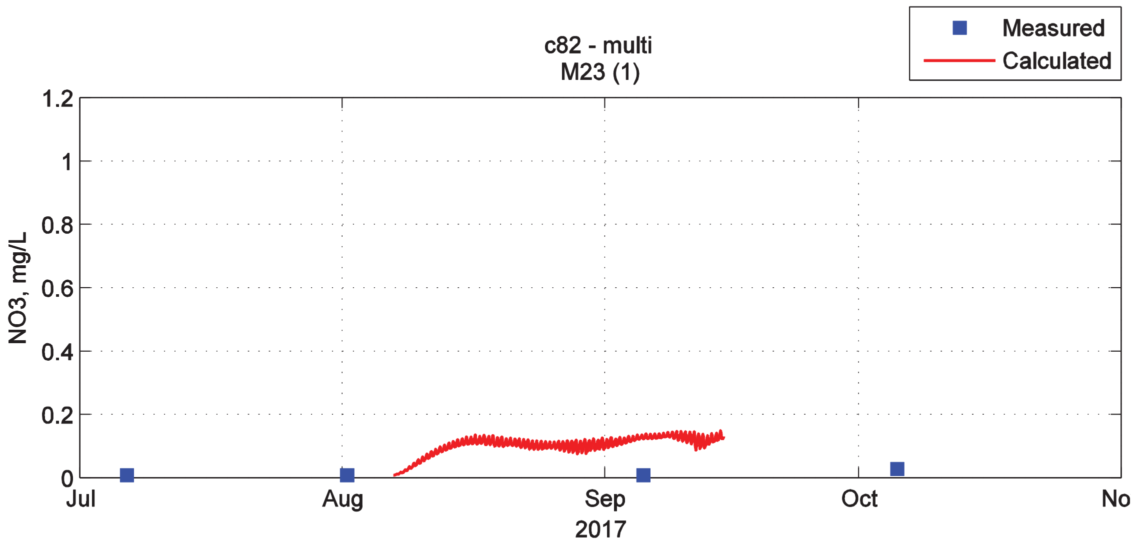

IC (1)

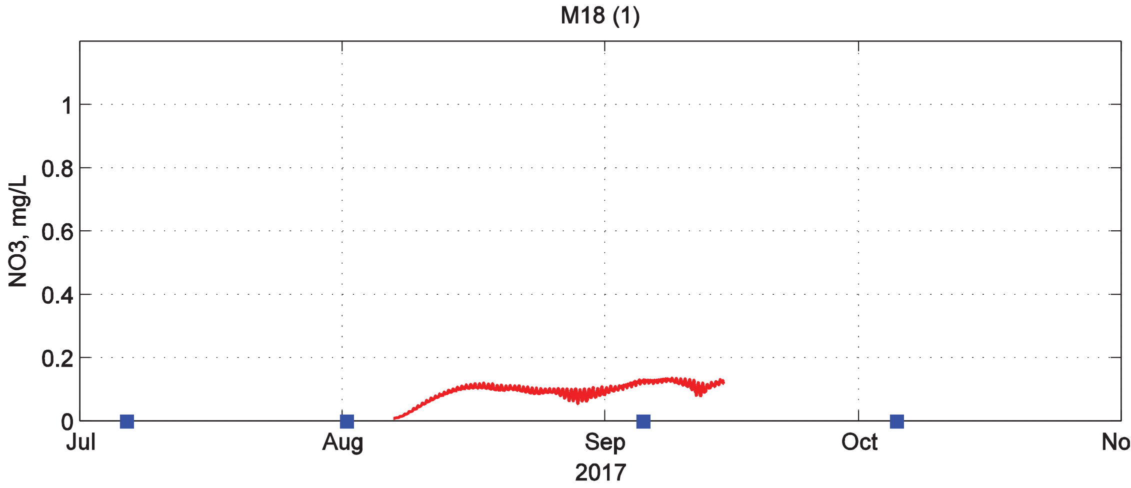

c82 - multi
NAV (1)

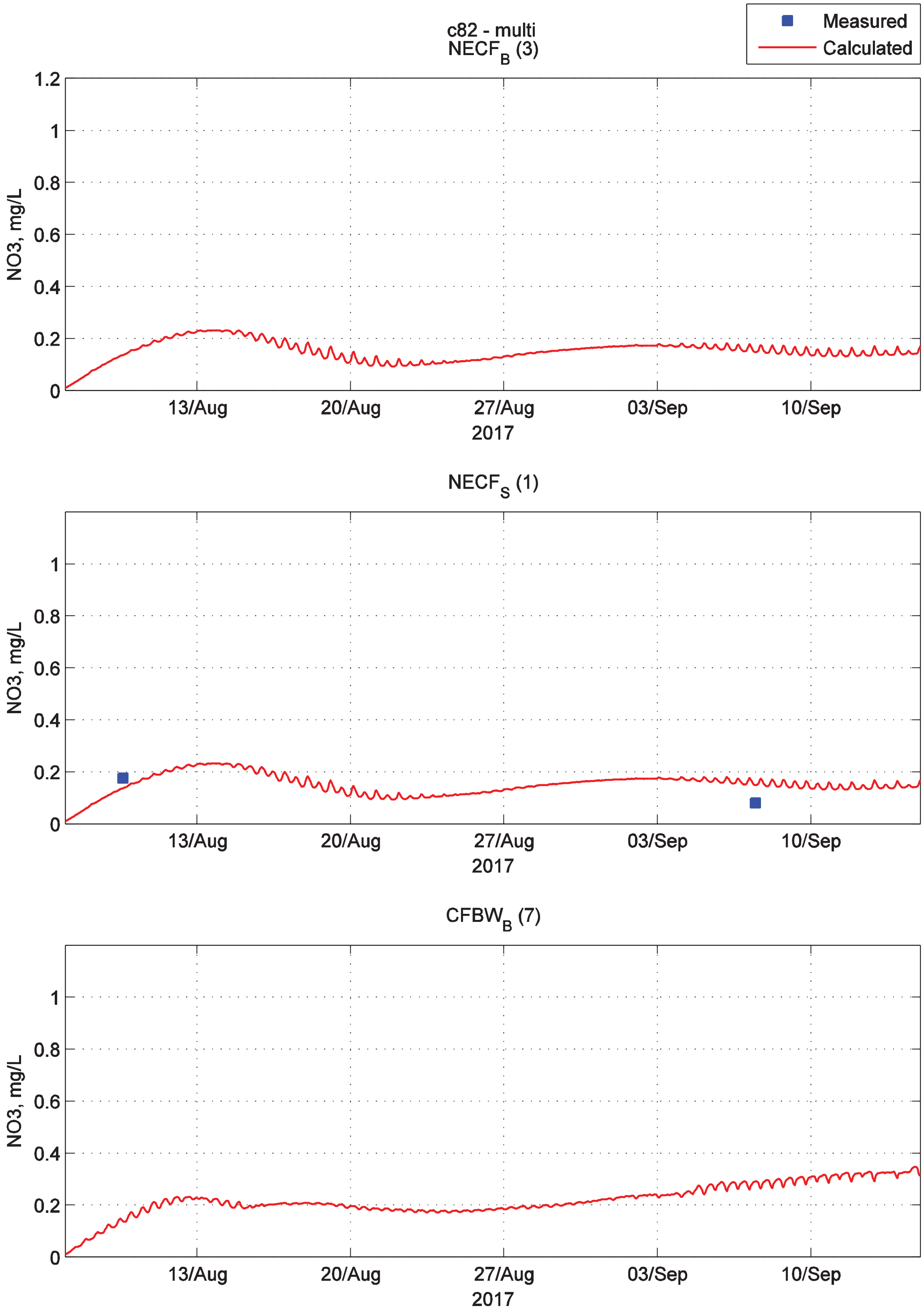

HB (1)

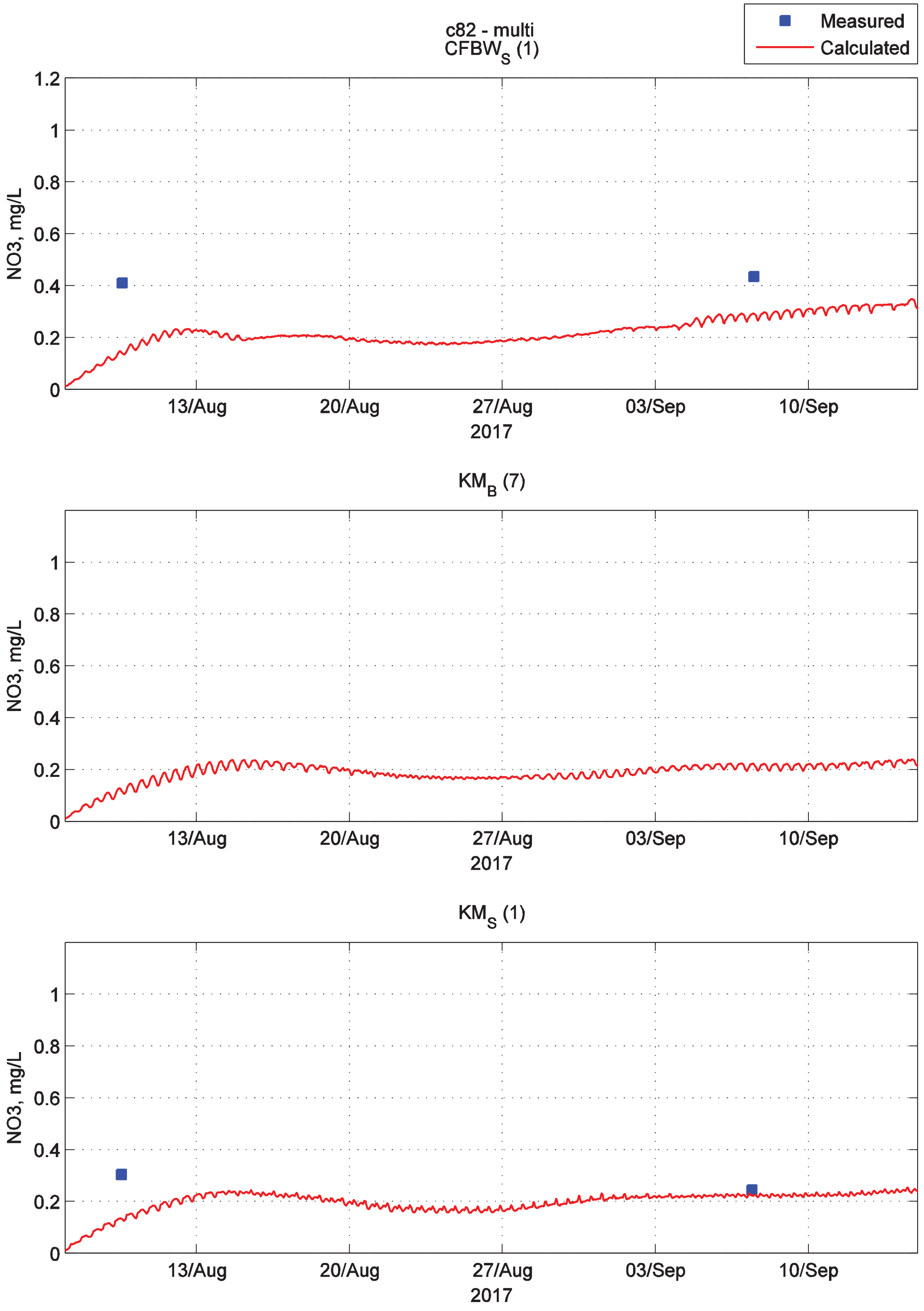

BRR (1)

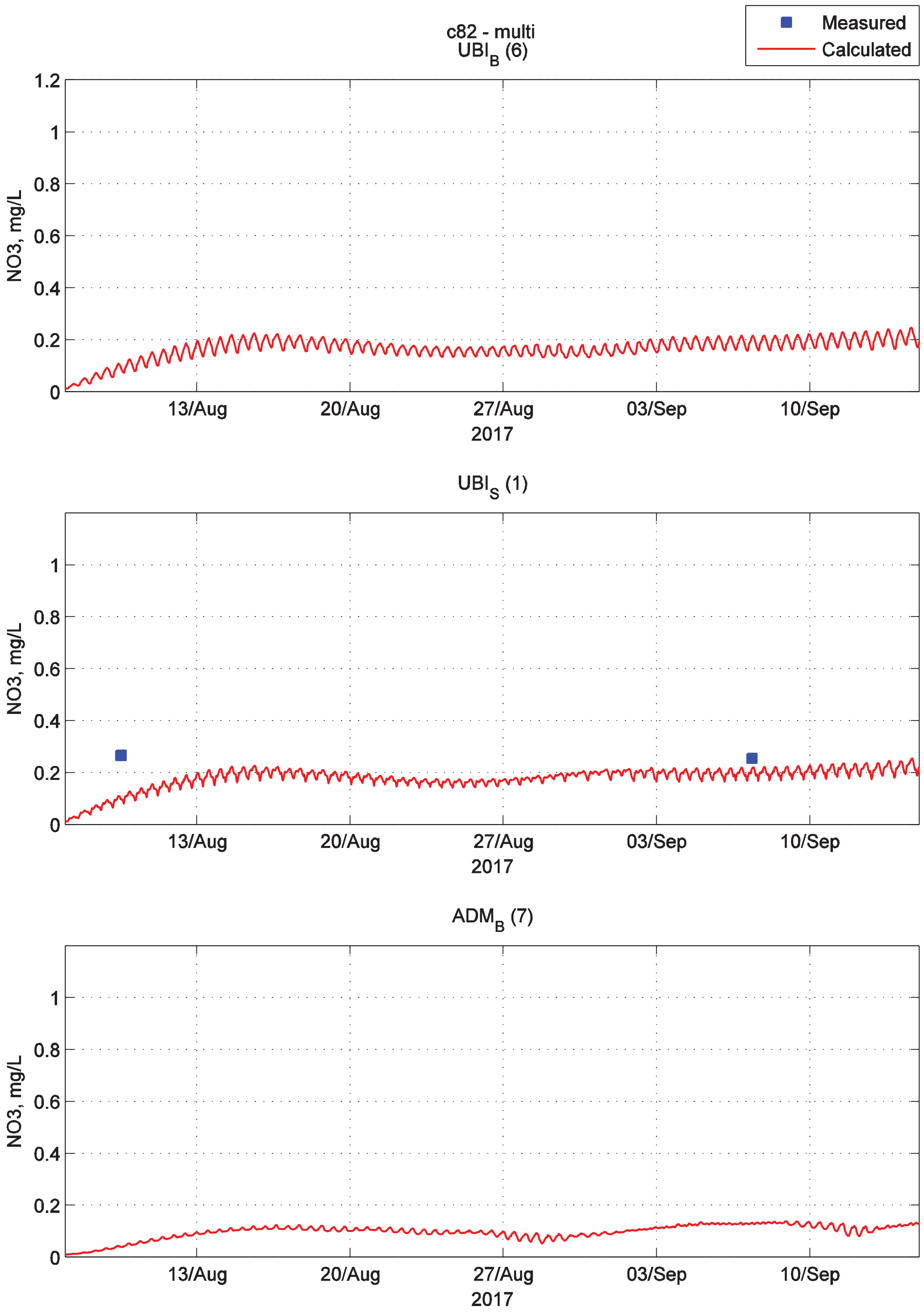

■ Measured
Calculated
c82 - multi
M61 (1)
M54 (1)
M35 (1)
NO3, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

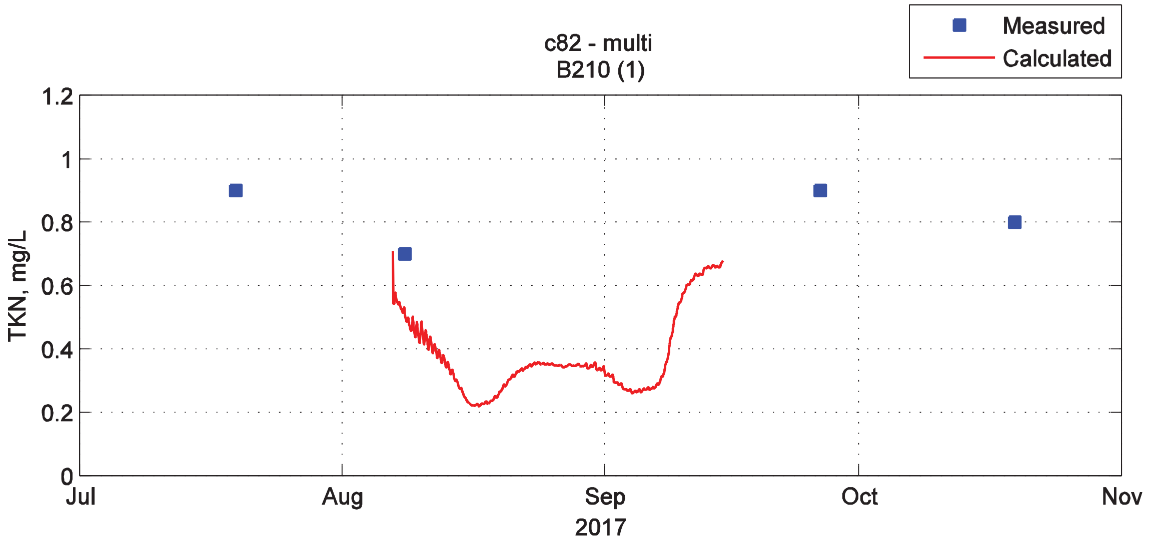

■ Measured
Calculated
c82 - multi
M23 (1)
NO3, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

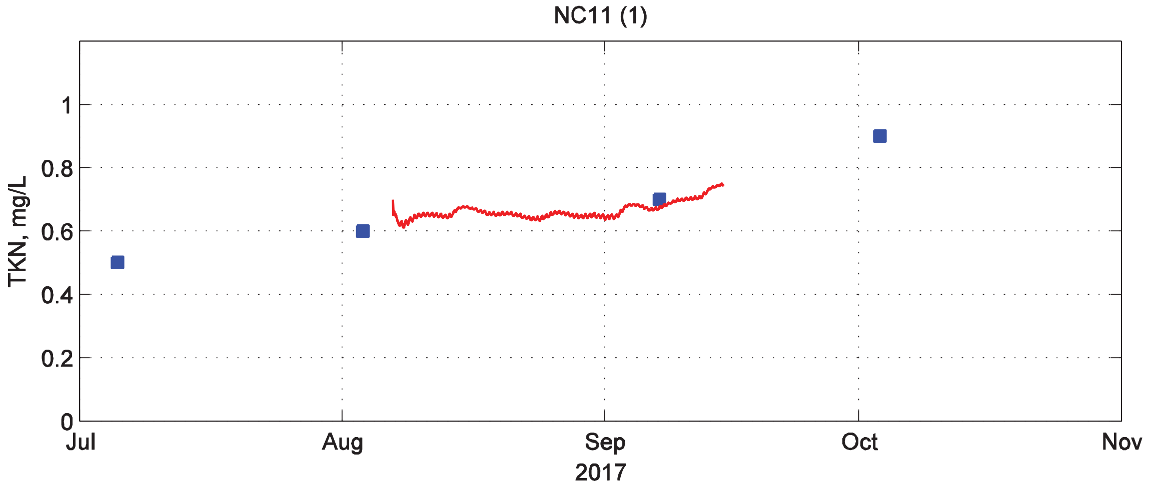

M18 (1)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

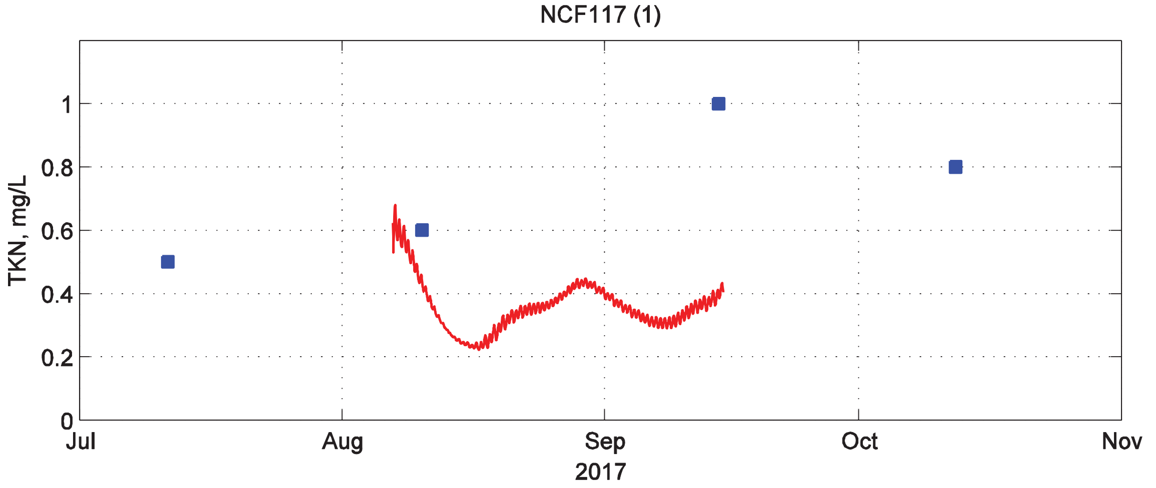

c82 - multi
NECF$_B$ (3)
■ Measured
Calculated
NO3, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF$_S$ (1)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW$_B$ (7)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

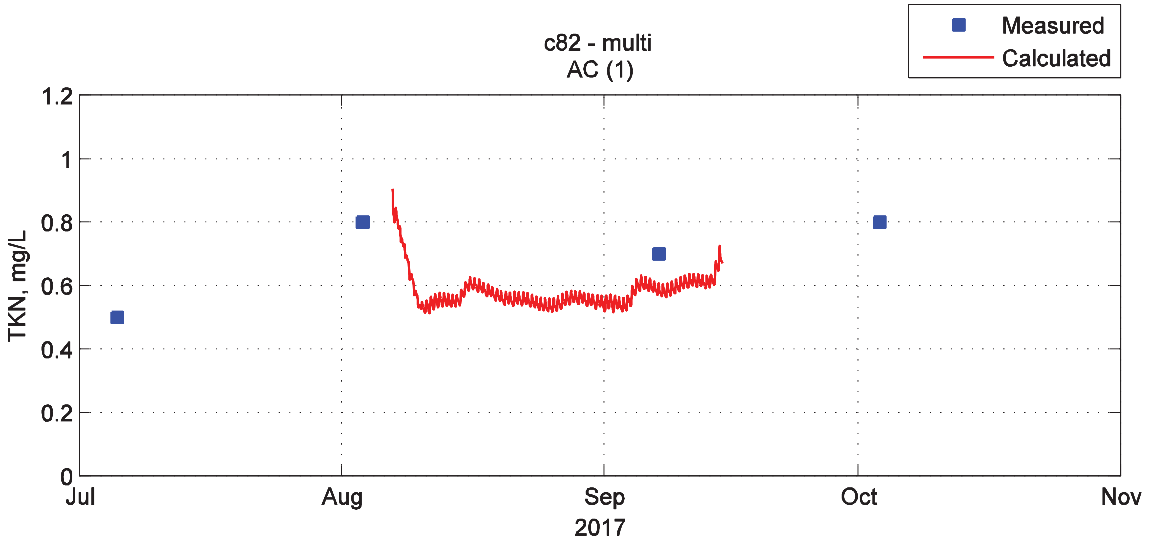

Measured
Calculated
c82 - multi
$CFBW_S$ (1)
NO3, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM_B (7)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM_S (1)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

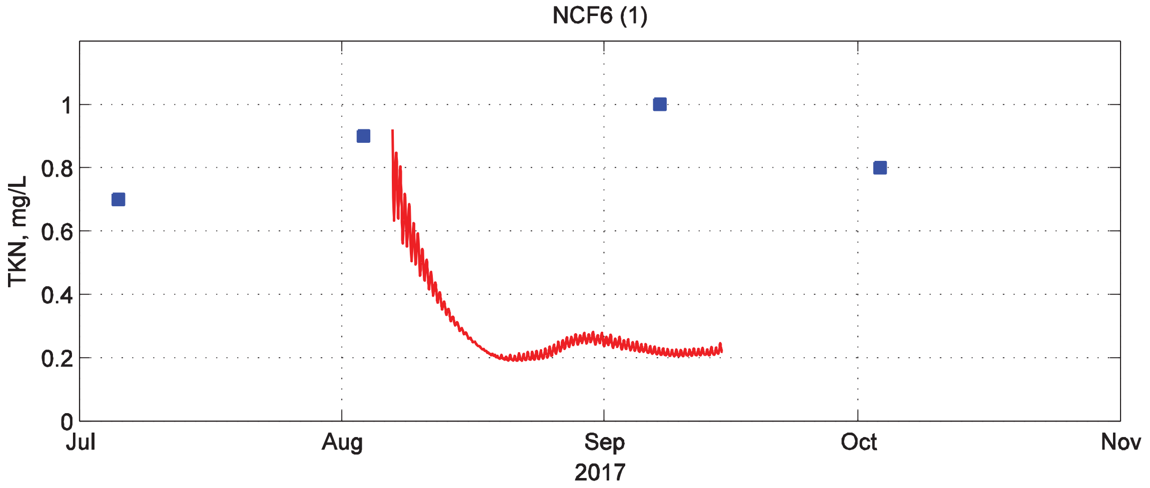

c82 - multi
UBI_B (6)
Measured
Calculated
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
1.2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI_S (1)
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
ADM_B (7)
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

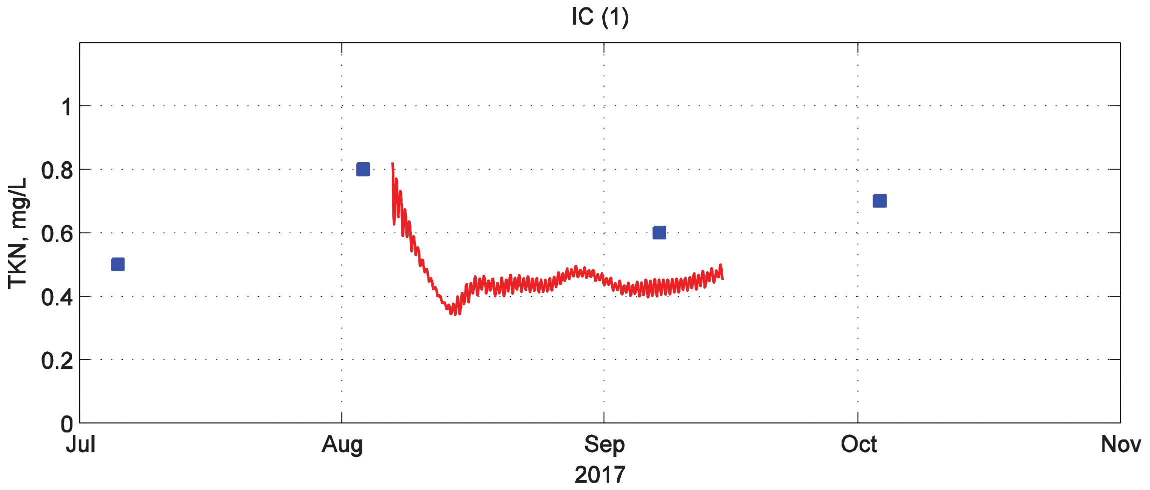

Measured
Calculated
c82 - multi
B210 (1)
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

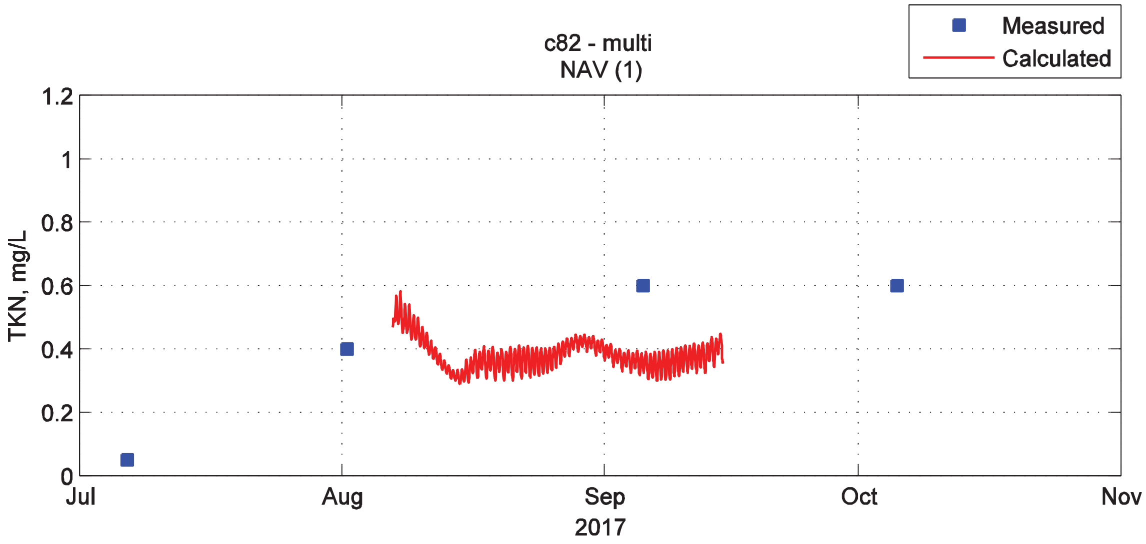

NC11 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

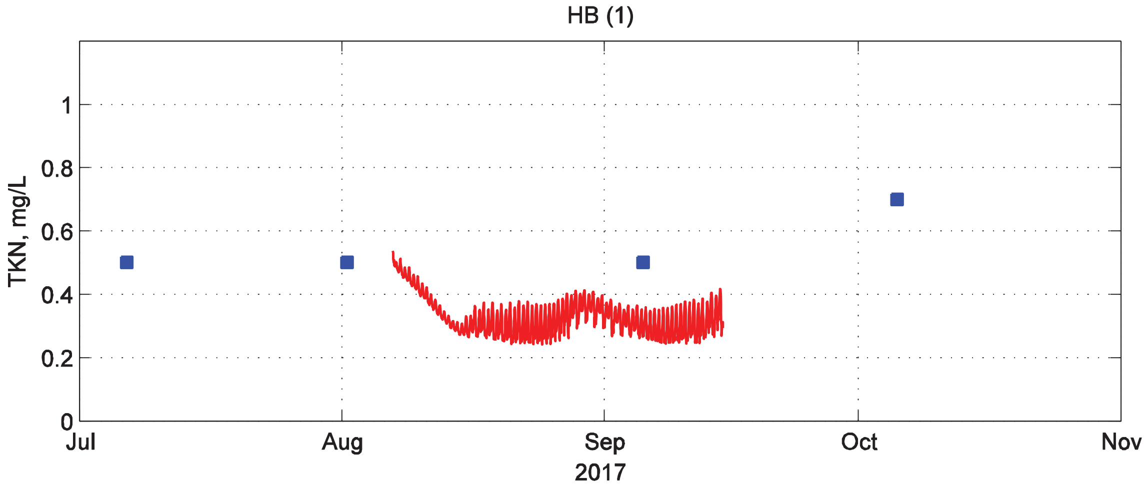

NCF117 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

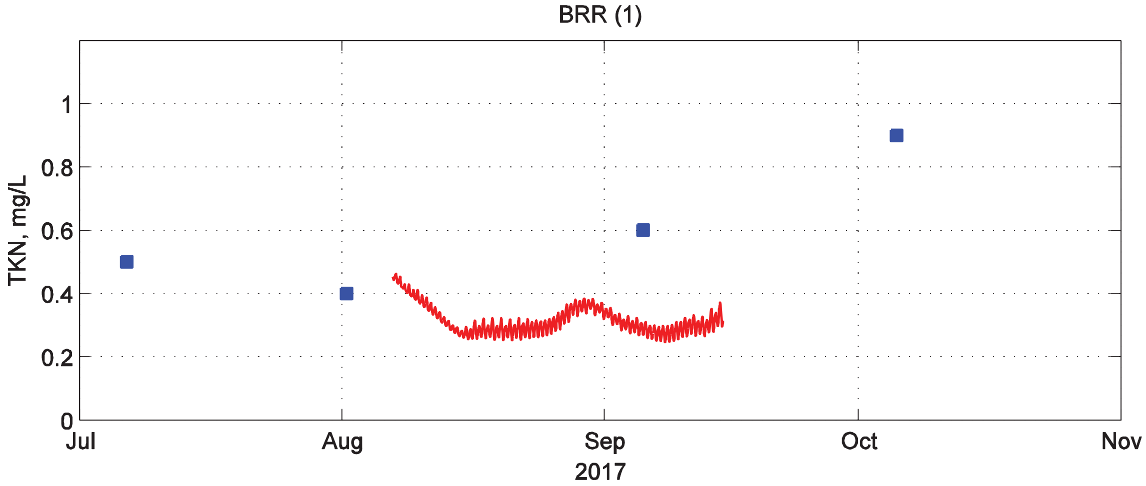

c82 - multi
AC (1)

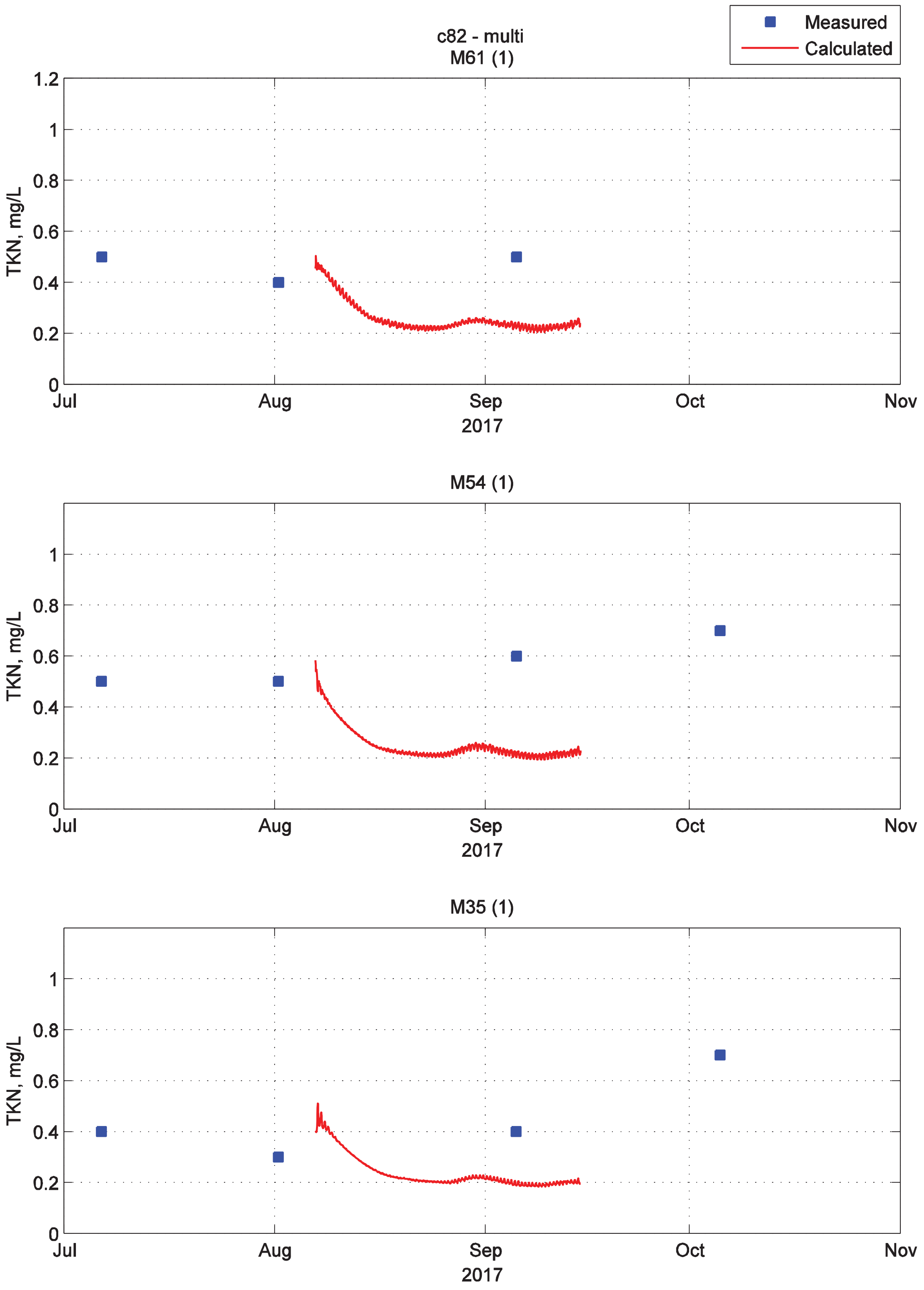

NCF6 (1)

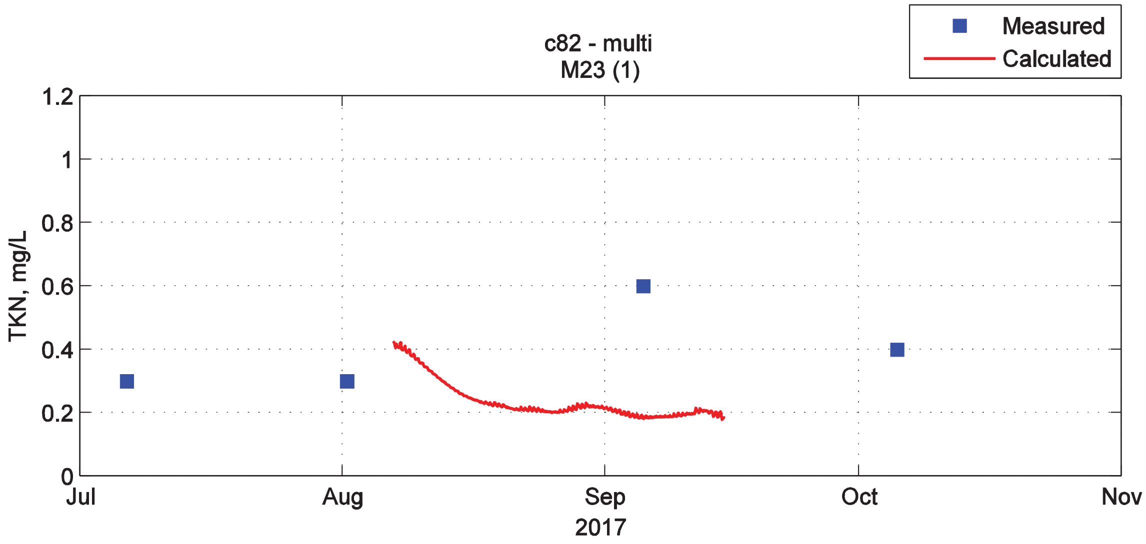

IC (1)

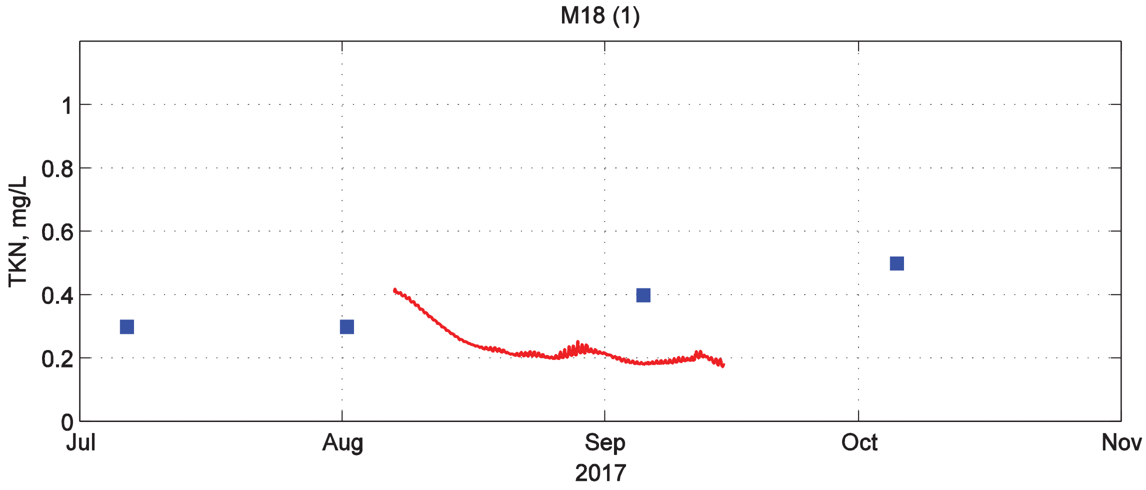

c82 - multi
NAV (1)

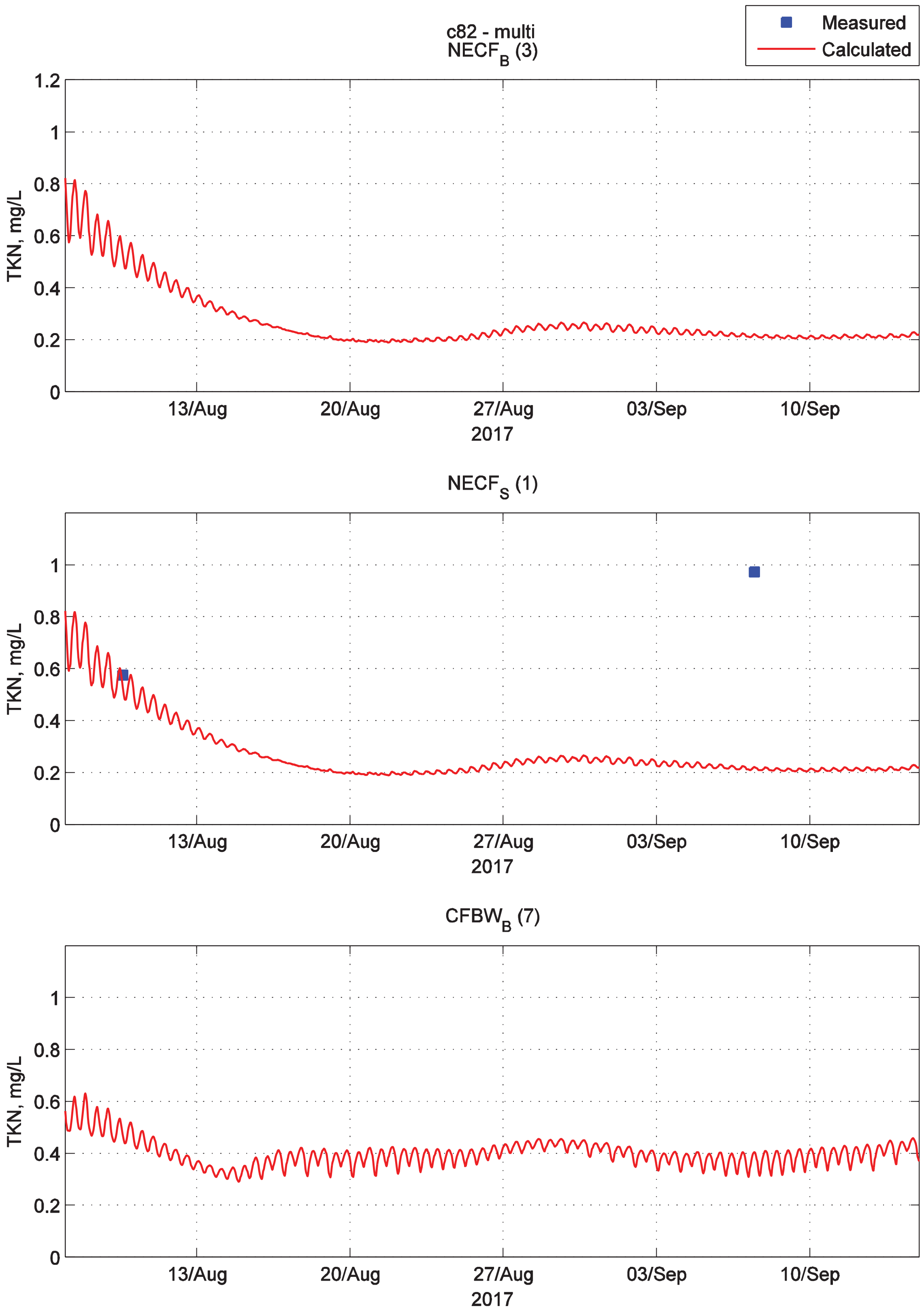

HB (1)

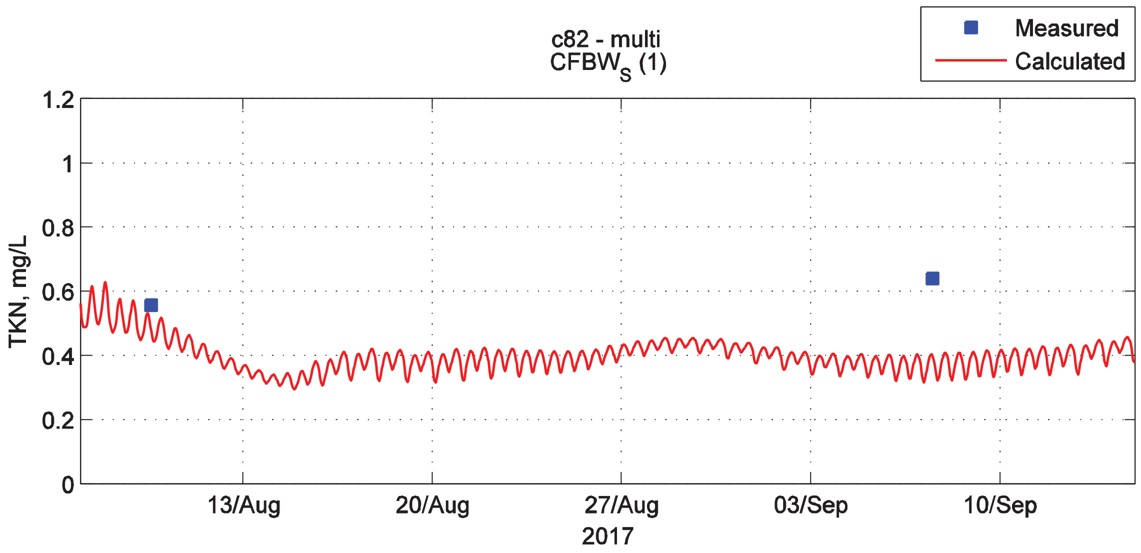

BRR (1)


Measured
Calculated
c82 - multi
M61 (1)
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017
M54 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017
M35 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

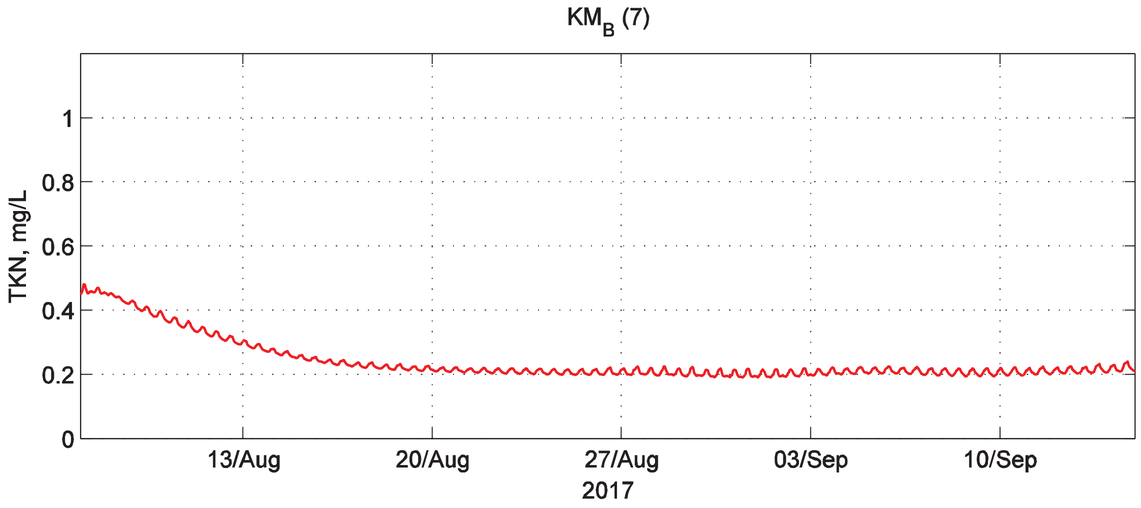

Measured
Calculated
c82 - multi
M23 (1)
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017


M18 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
Jul
Aug
Sep
Oct
Nov
2017

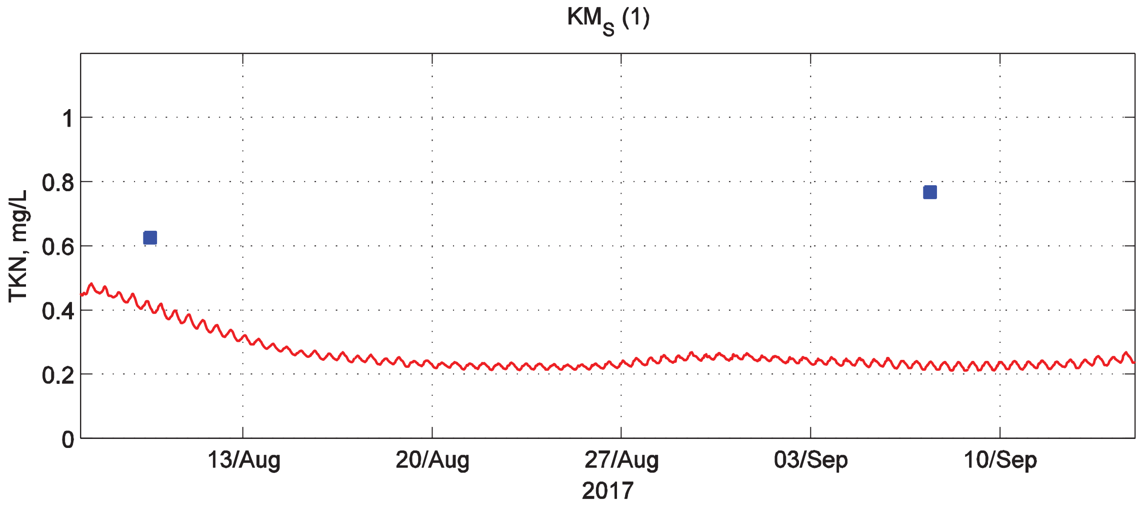

■ Measured
Calculated
c82 - multi
NECF$_B$ (3)
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF$_S$ (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW$_B$ (7)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017



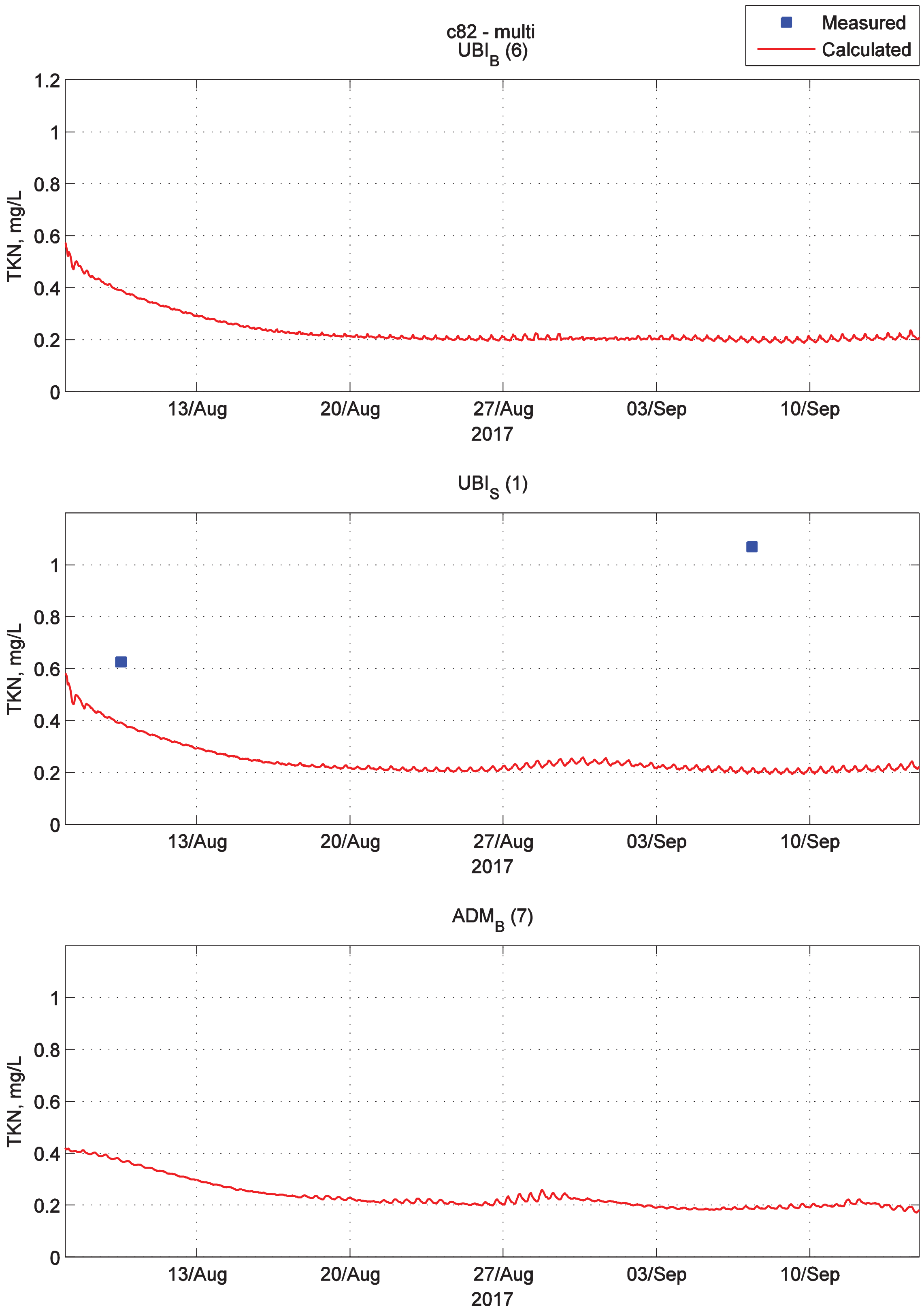
c82 - multi
CFBW$_S$ (1)

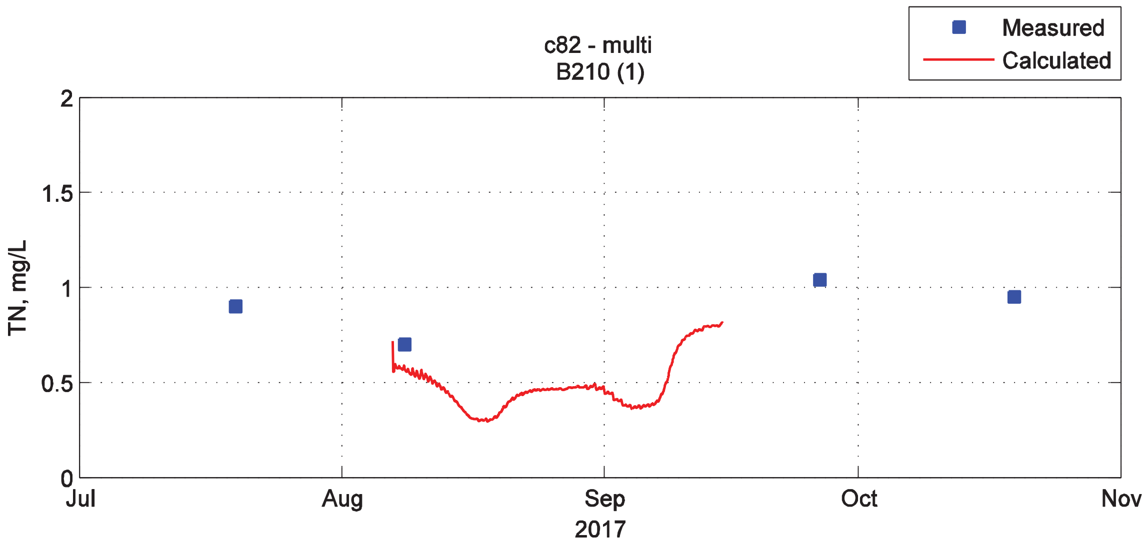


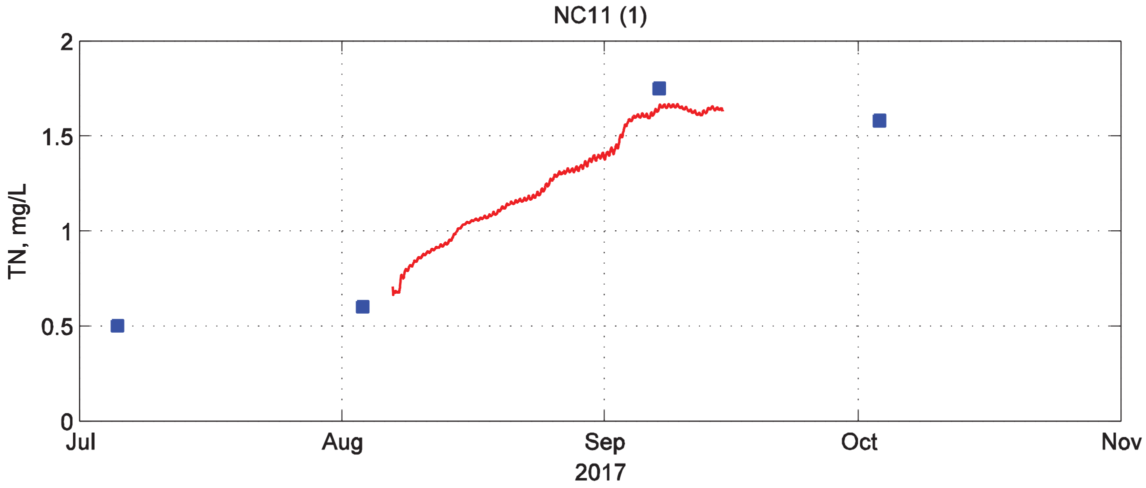
KM$_B$ (7)

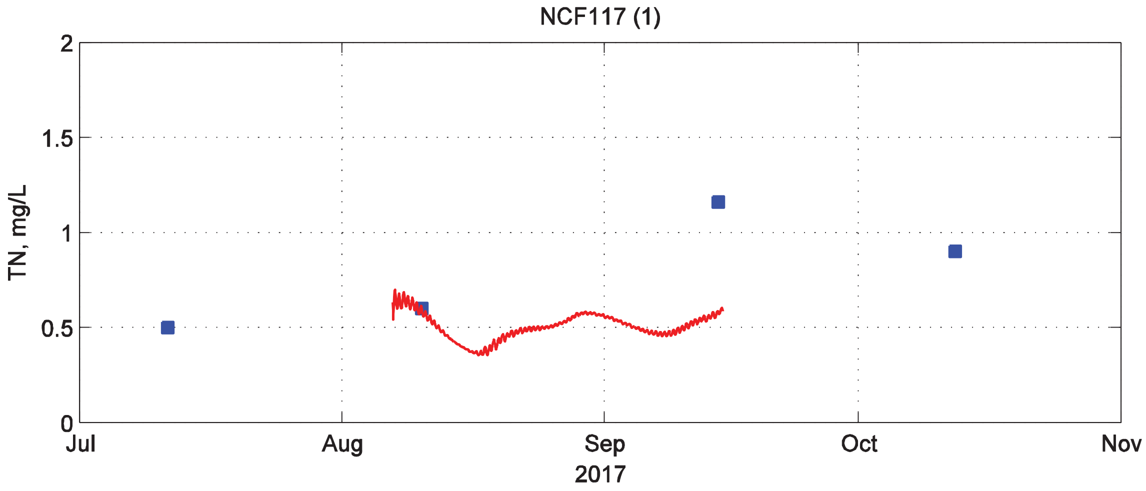


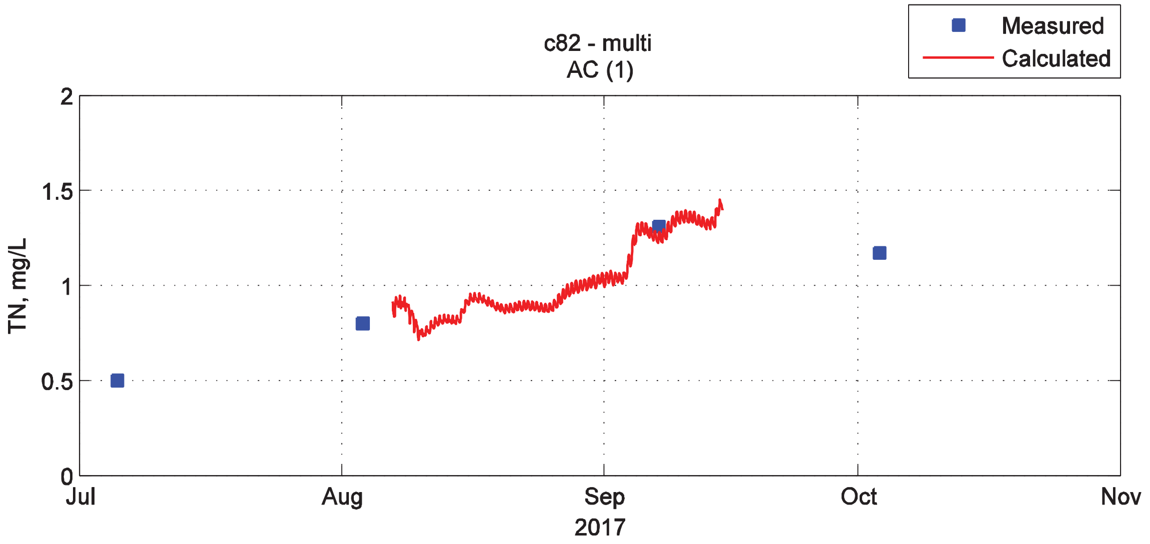
KM$_S$ (1)

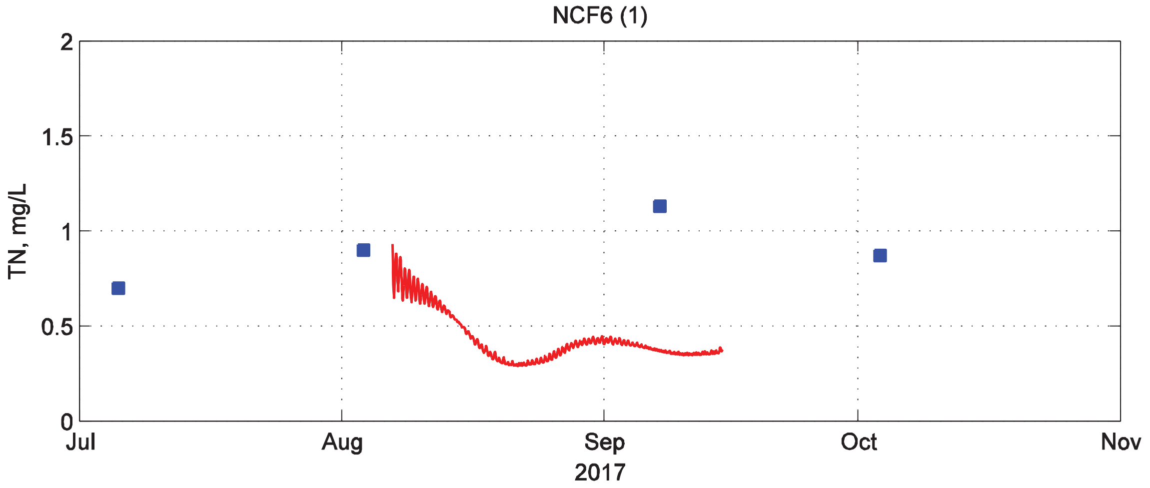

c82 - multi
Measured
Calculated
UBI$_B$ (6)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
1.2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI$_S$ (1)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
ADM$_B$ (7)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

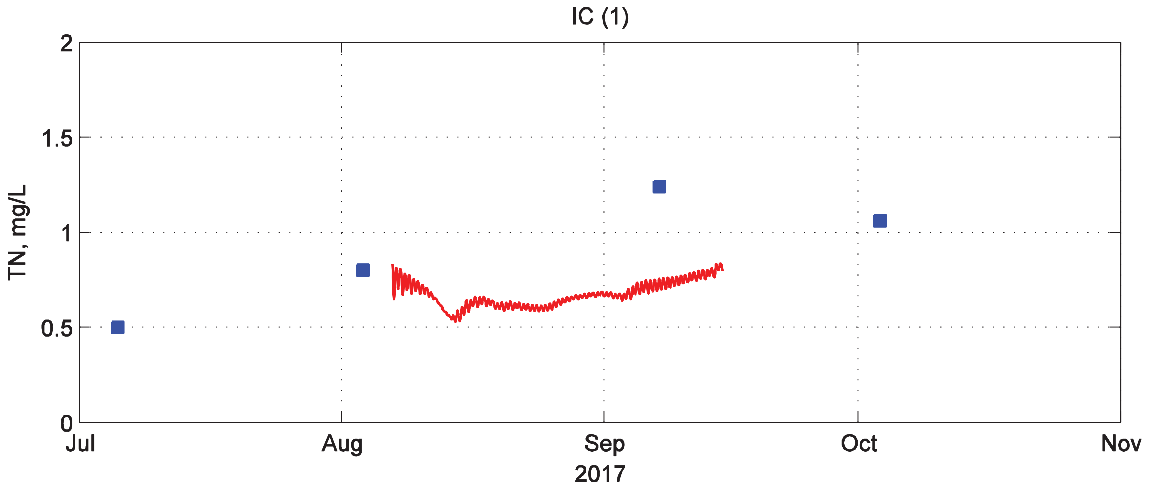

c82 - multi
B210 (1)

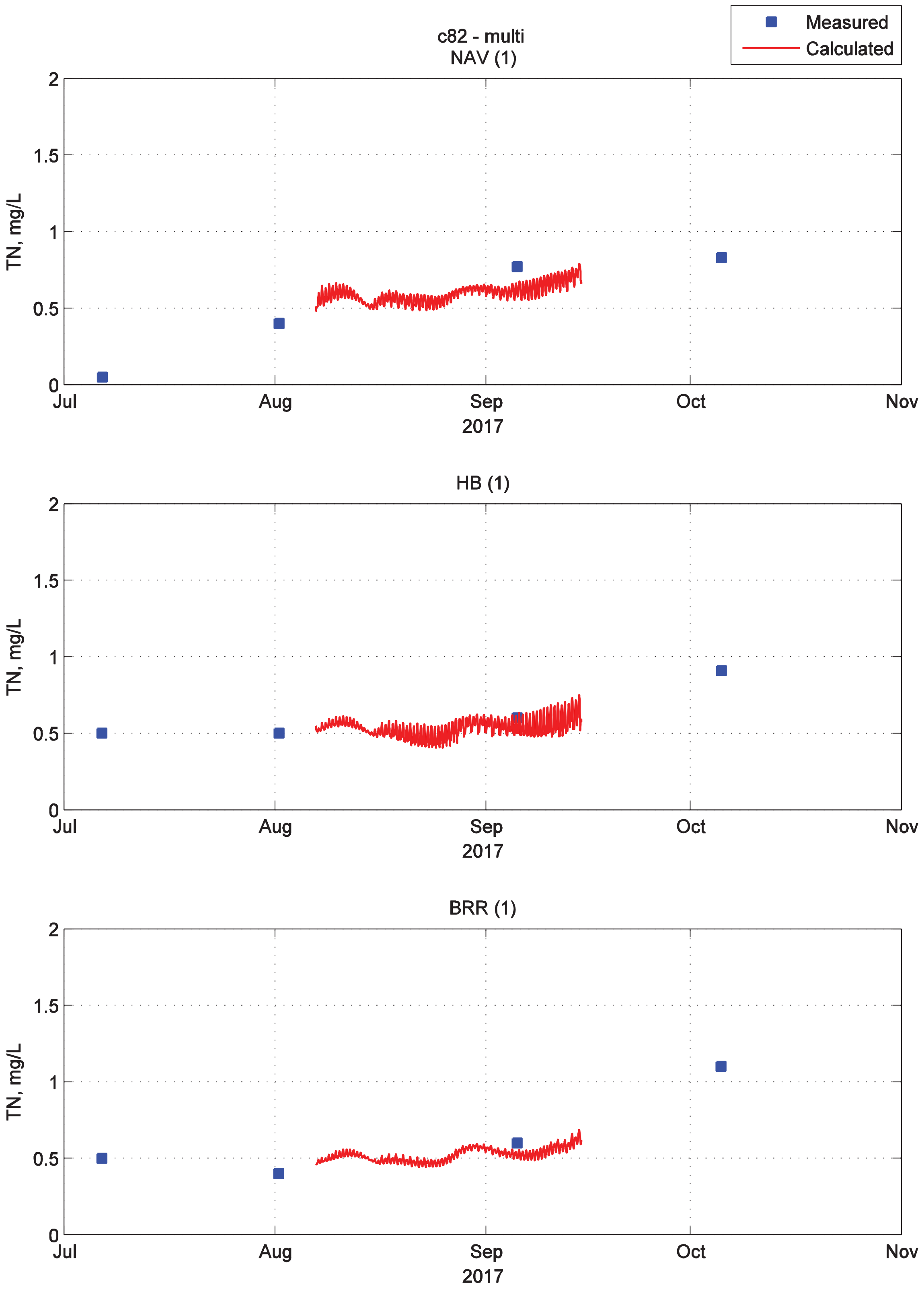

NC11 (1)

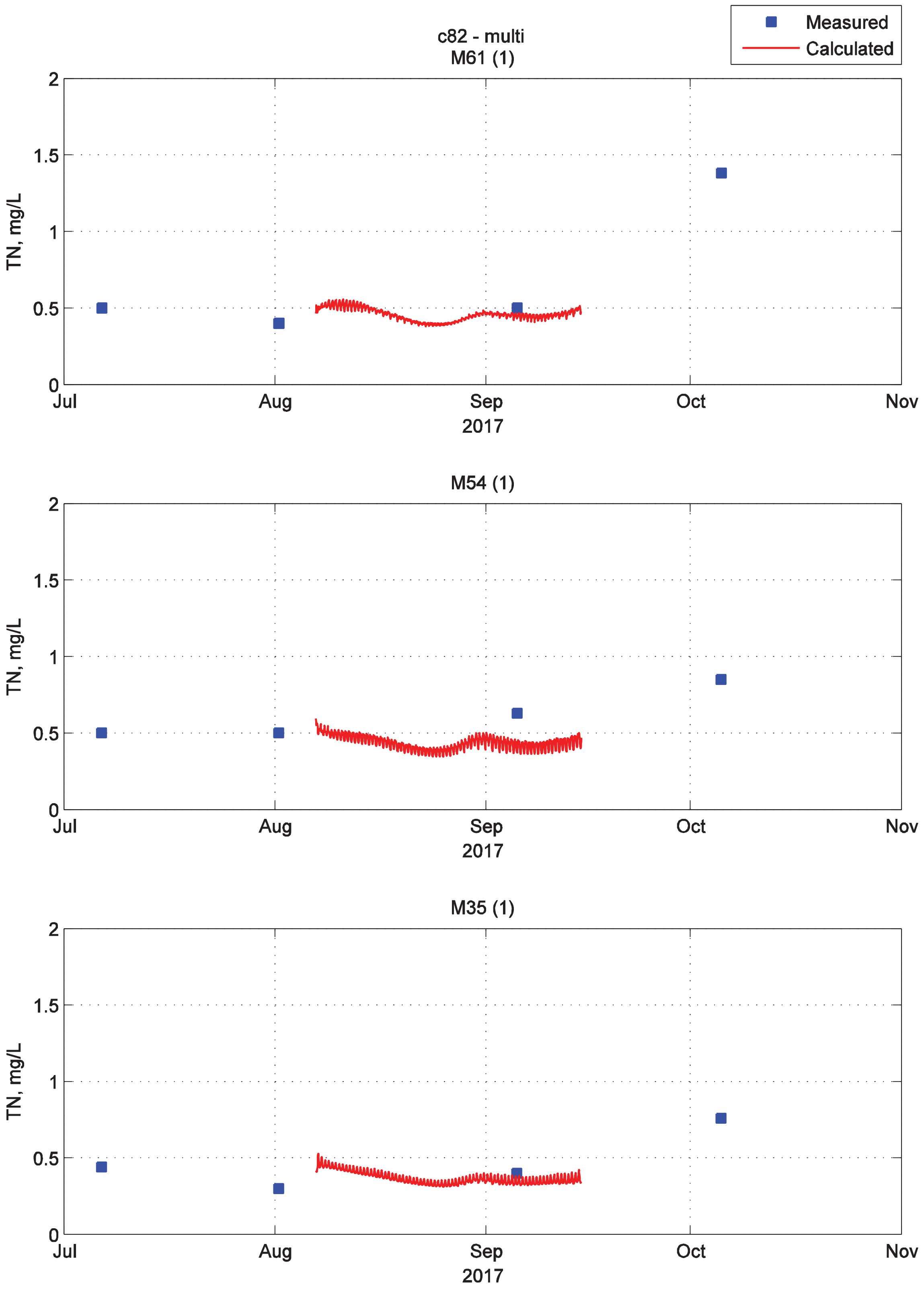

NCF117 (1)

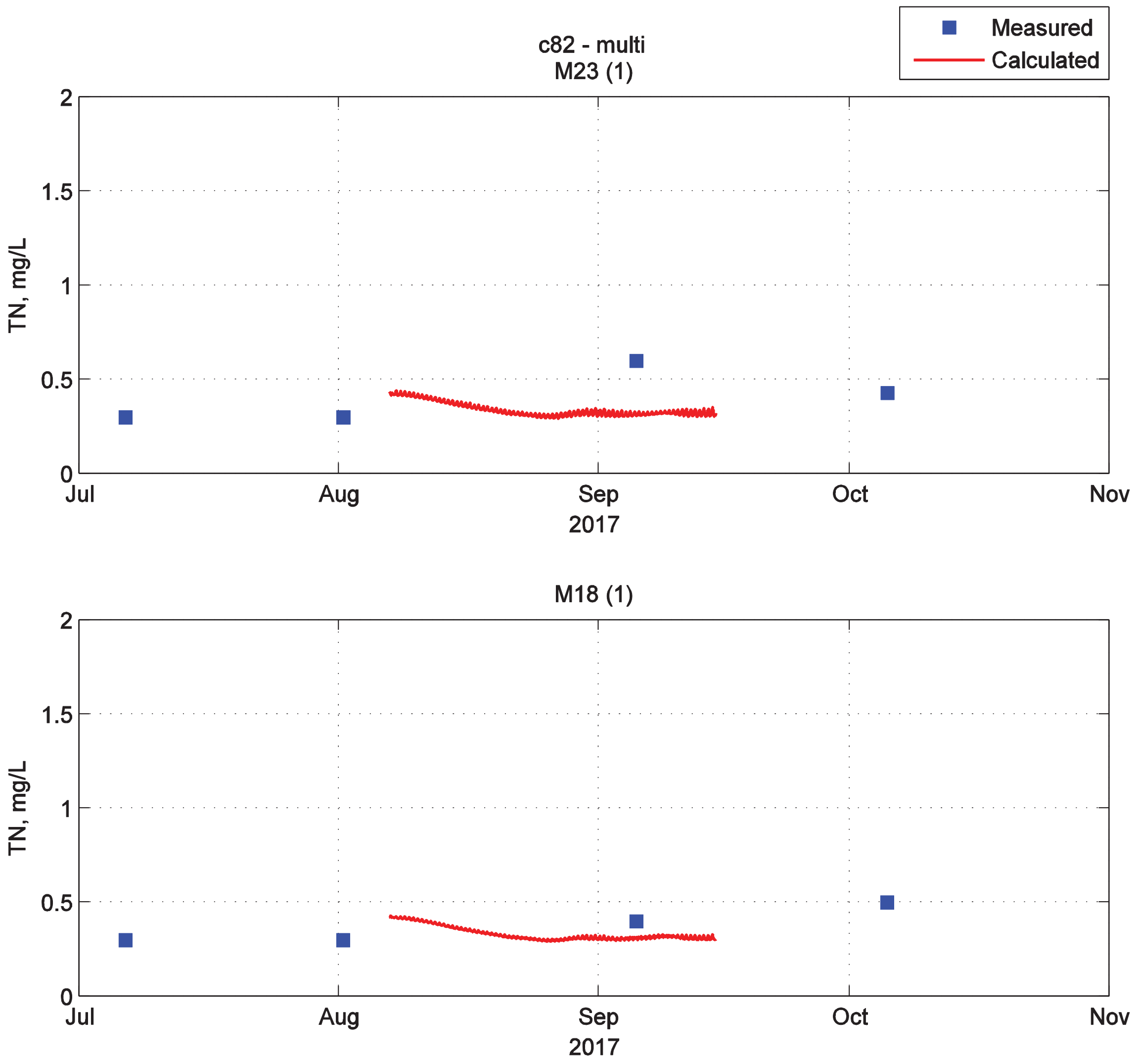

c82 - multi
AC (1)

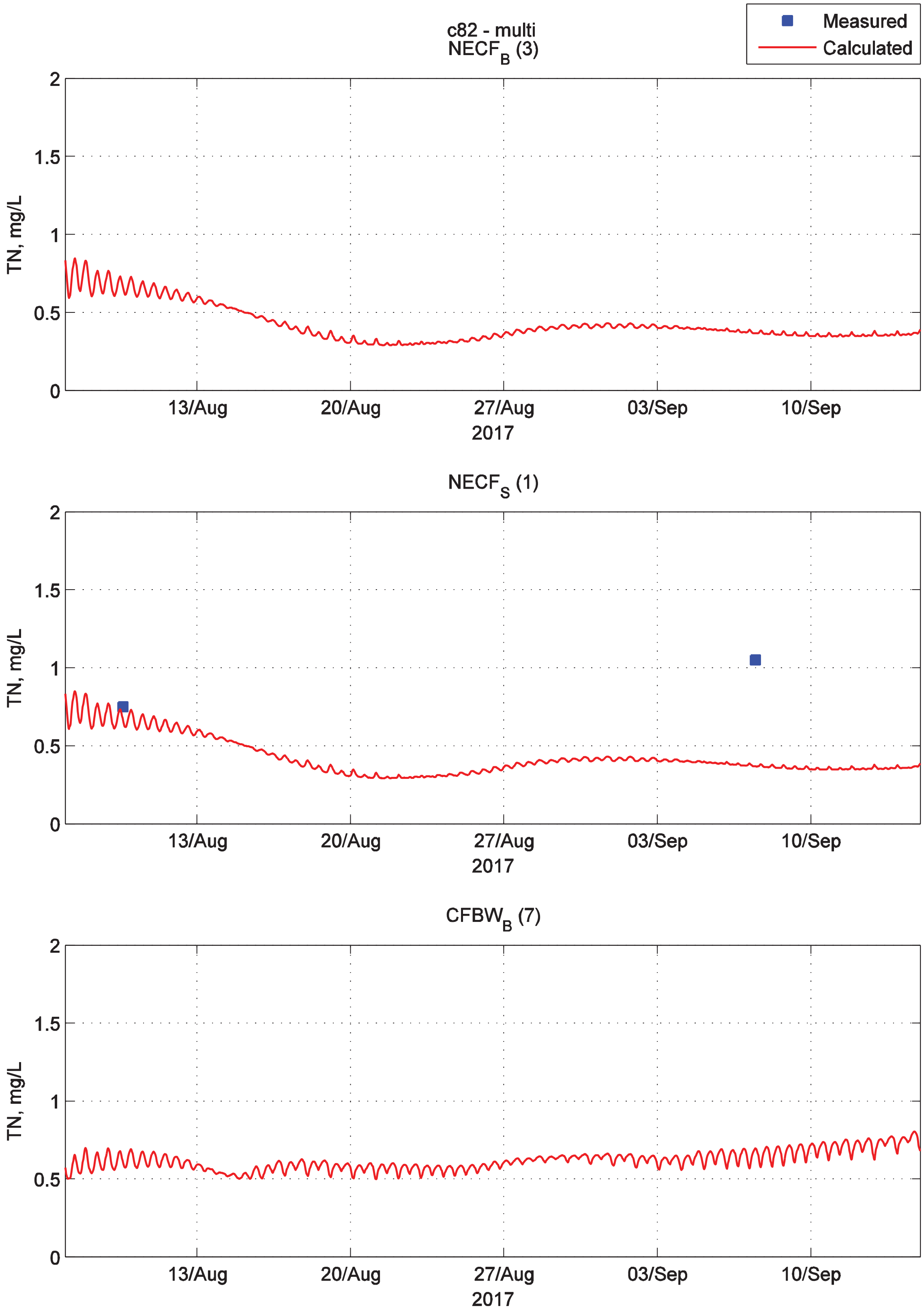

NCF6 (1)

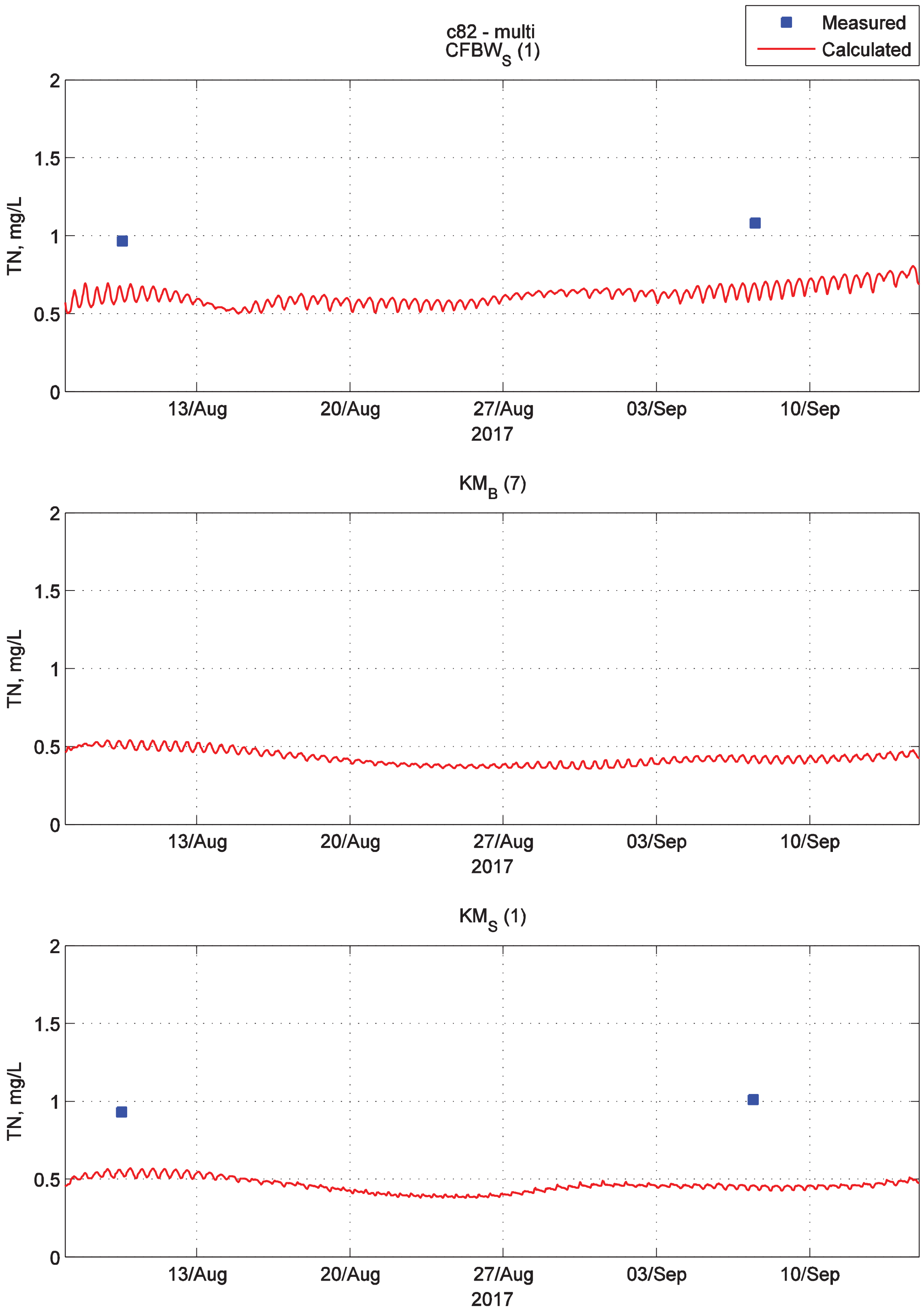

IC (1)

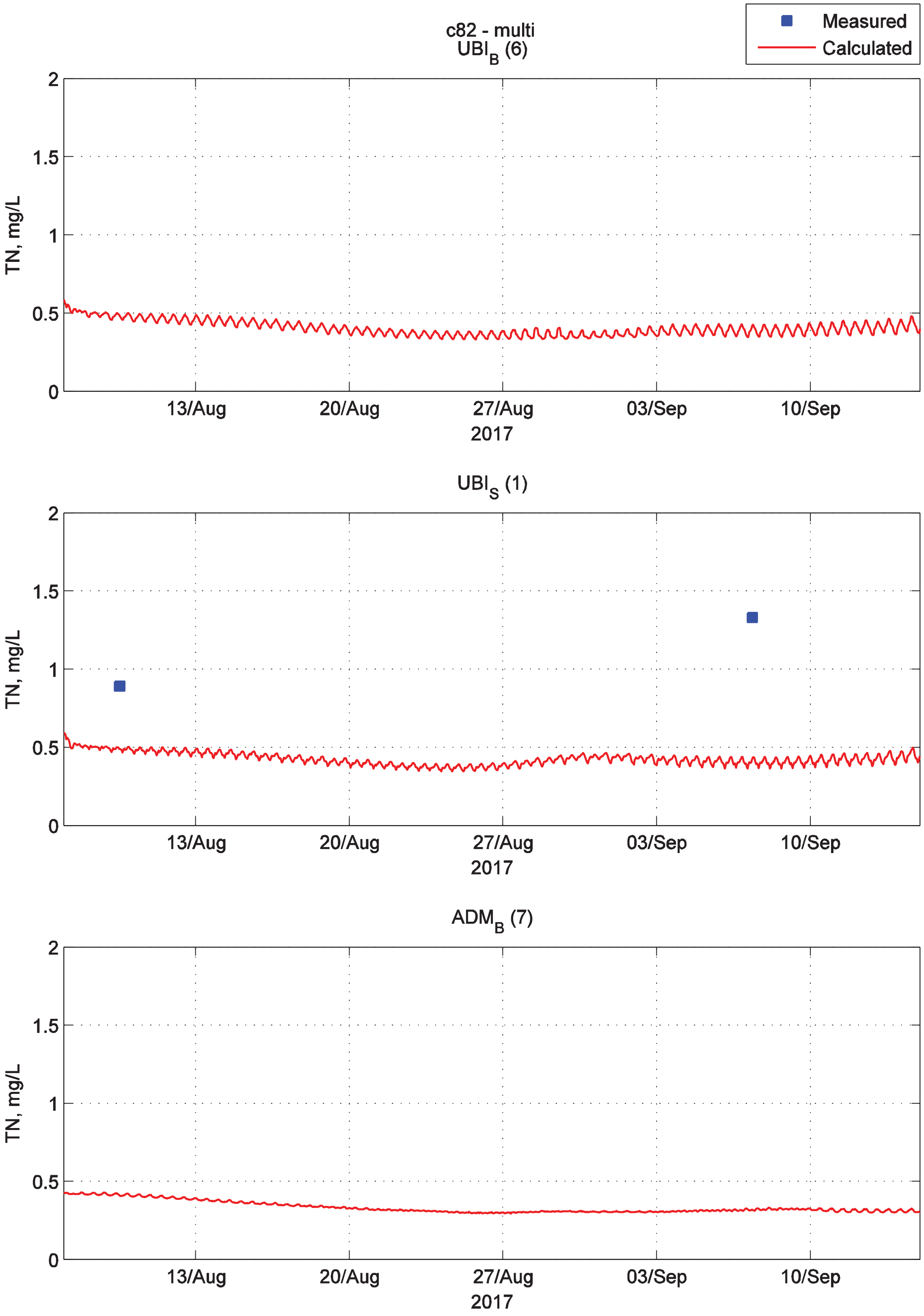

■ Measured
— Calculated
c82 - multi
NAV (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017
HB (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017
BRR (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017

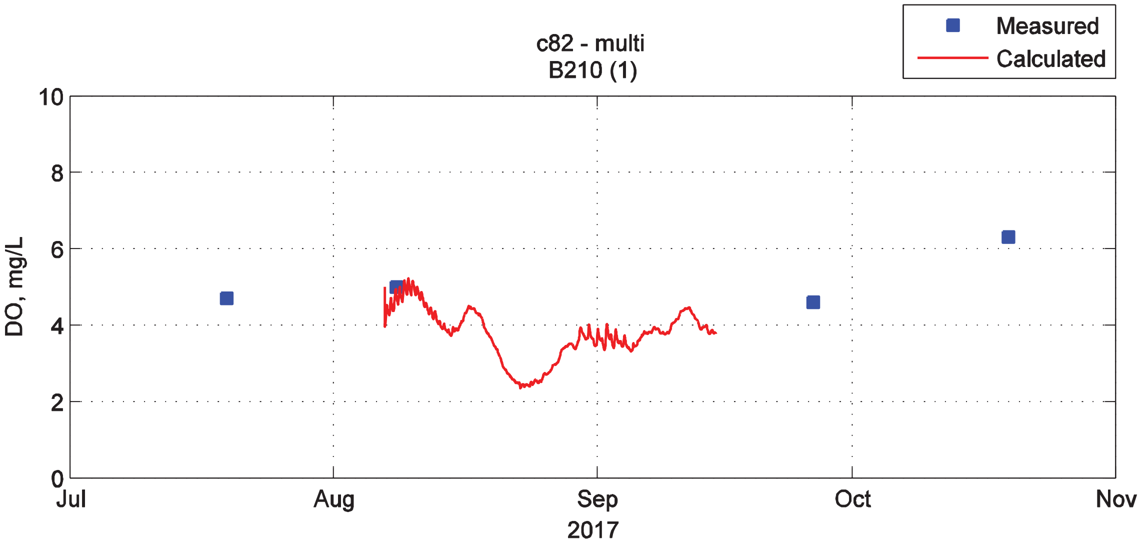

Measured
Calculated
c82 - multi
M61 (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017
M54 (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017
M35 (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017


Measured
Calculated
c82 - multi
M23 (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017
M18 (1)
TN, mg/L
2
1.5
1
0.5
0
Jul
Aug
Sep
Oct
Nov
2017

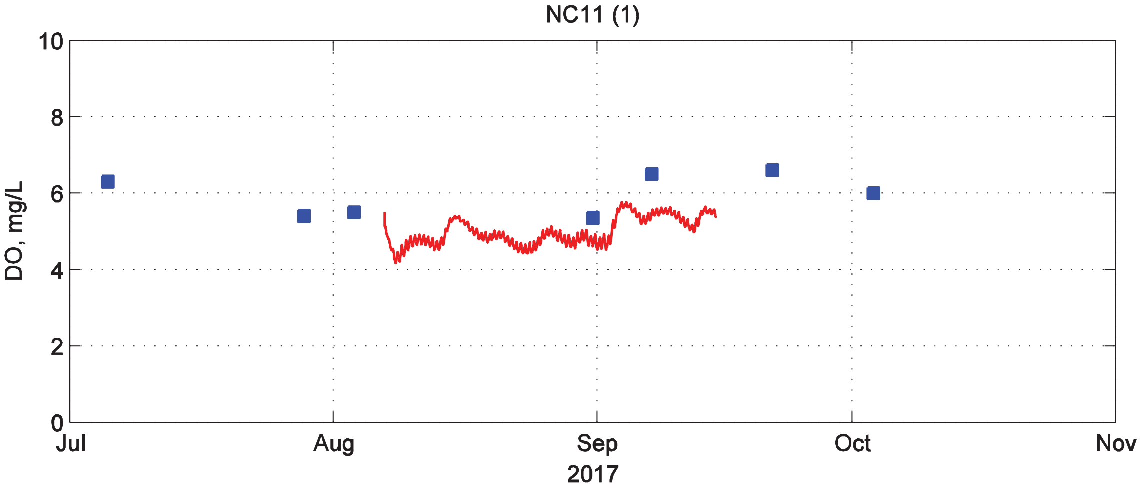

c82 - multi
NECF_B (3)
■ Measured
Calculated
TN, mg/L
2
1.5
1
0.5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF_S (1)
CFBW_B (7)


Measured
Calculated
c82 - multi
CFBW$_S$ (1)
TN, mg/L
0
0.5
1
1.5
2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM$_B$ (7)
TN, mg/L
0
0.5
1
1.5
2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM$_S$ (1)
TN, mg/L
0
0.5
1
1.5
2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

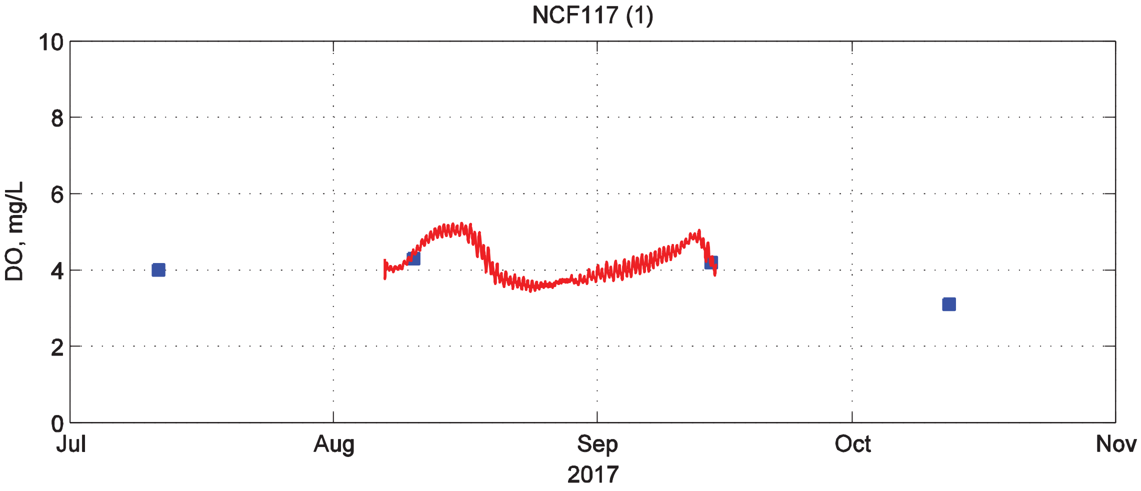

■ Measured
Calculated
c82 - multi
UBI$_B$ (6)
TN, mg/L
2
1.5
1
0.5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI$_S$ (1)
ADM$_B$ (7)



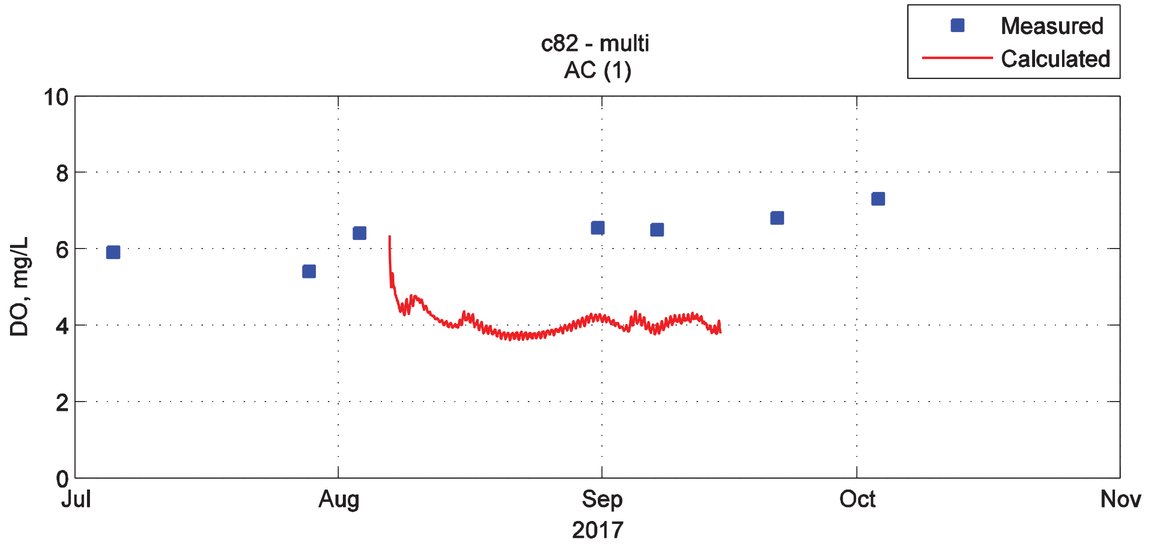
c82 - multi
B210 (1)

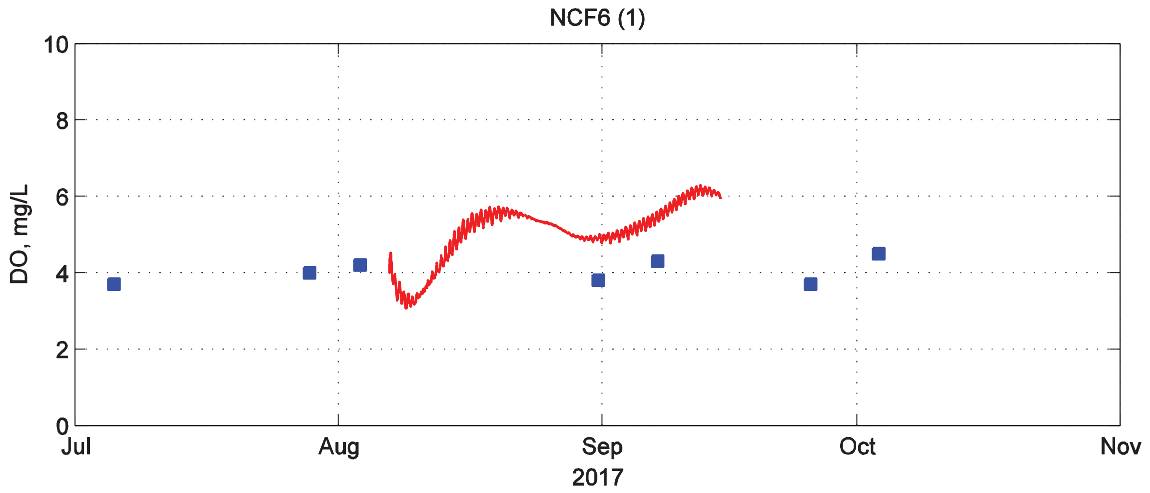


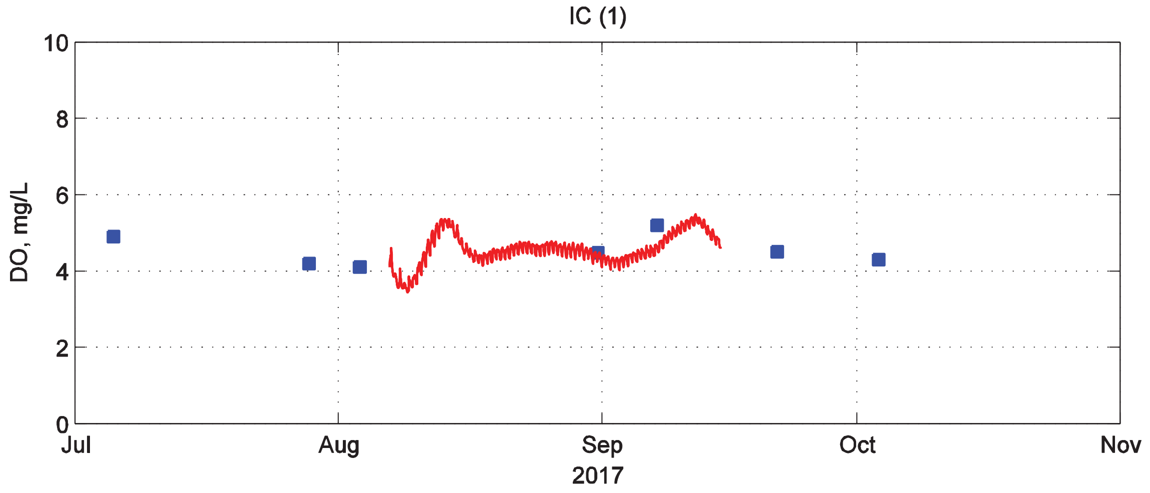
NC11 (1)

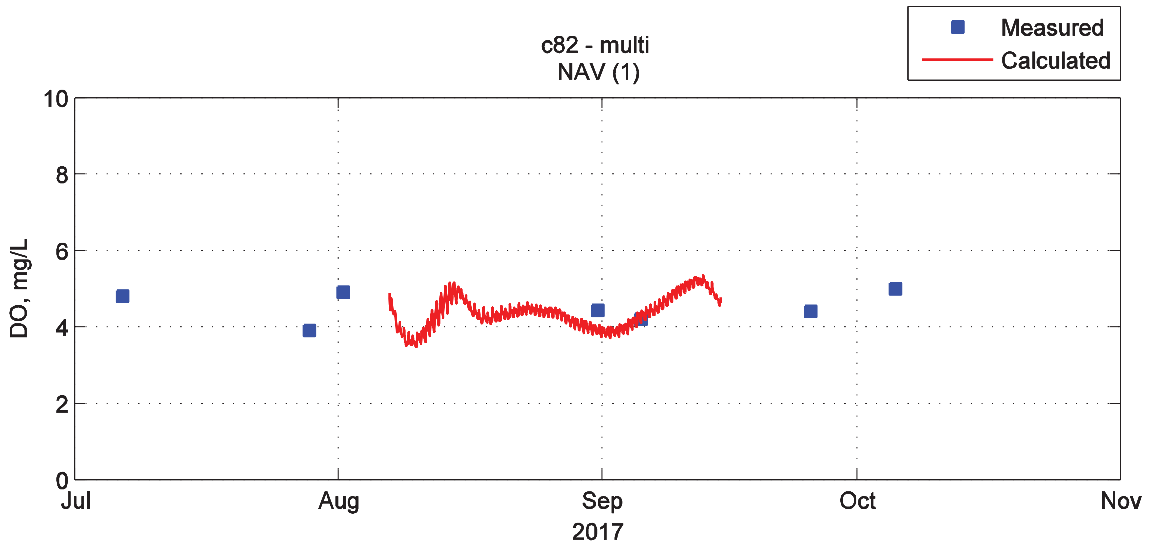


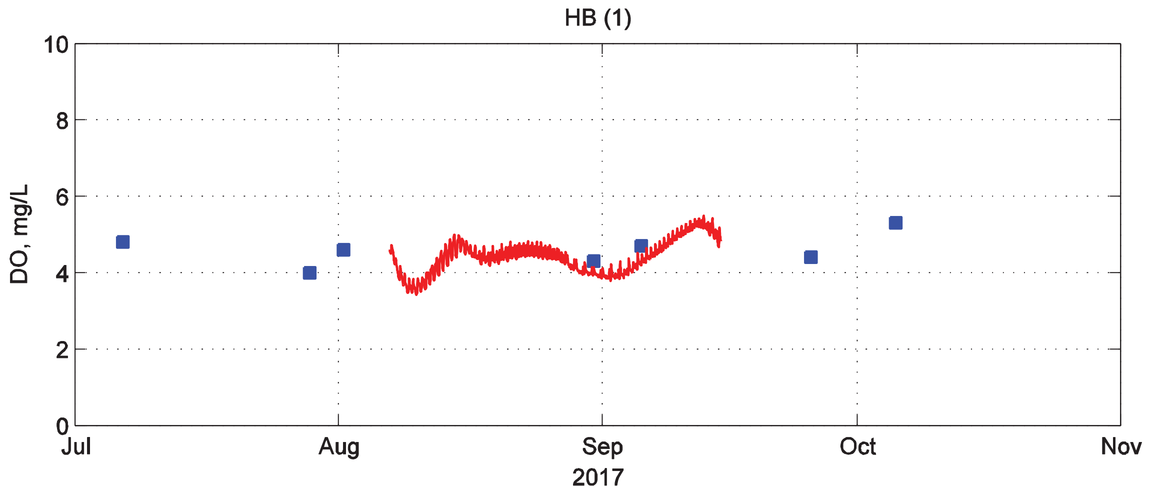
NCF117 (1)

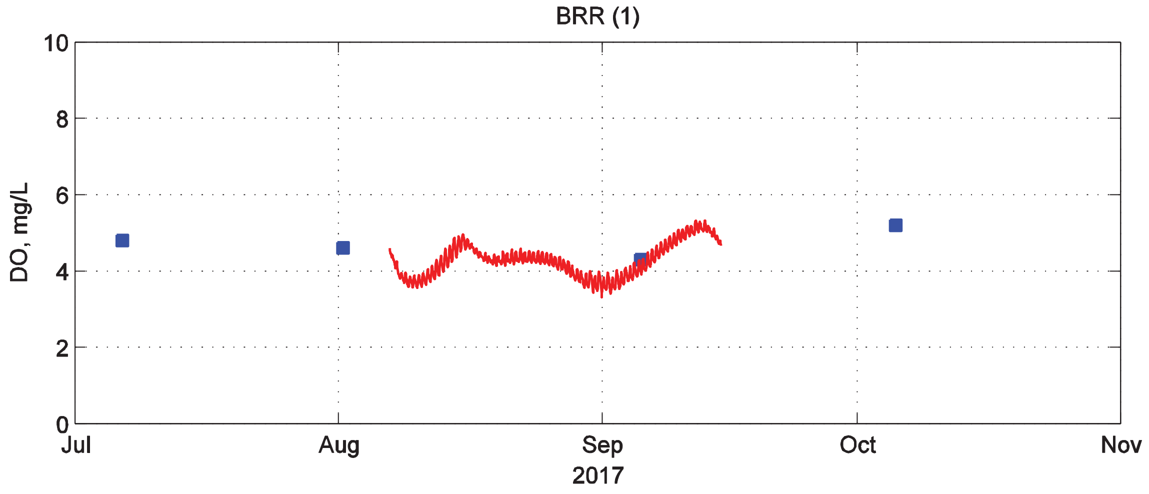

c82 - multi
AC (1)

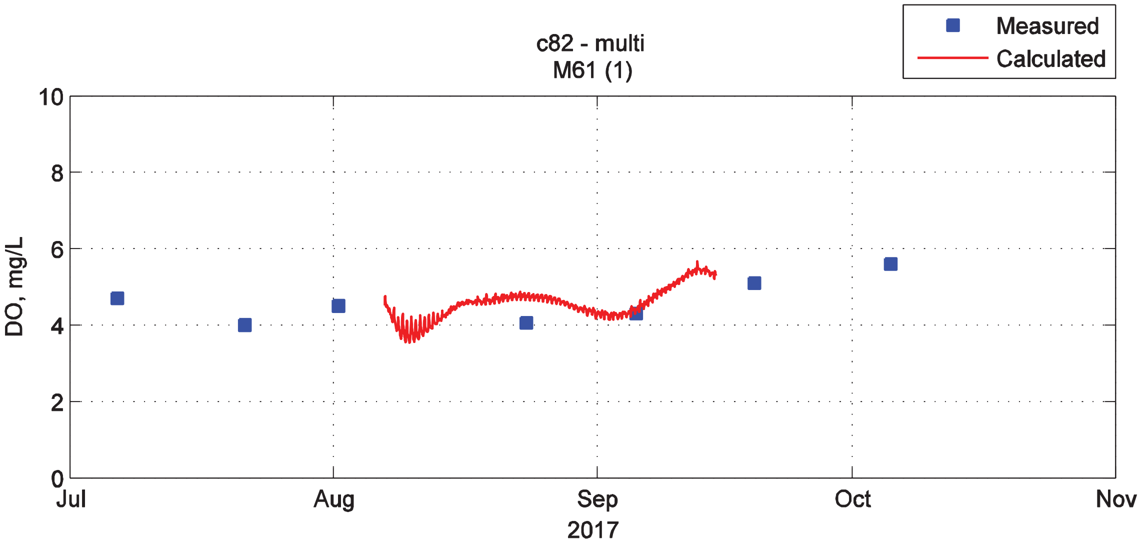

NCF6 (1)

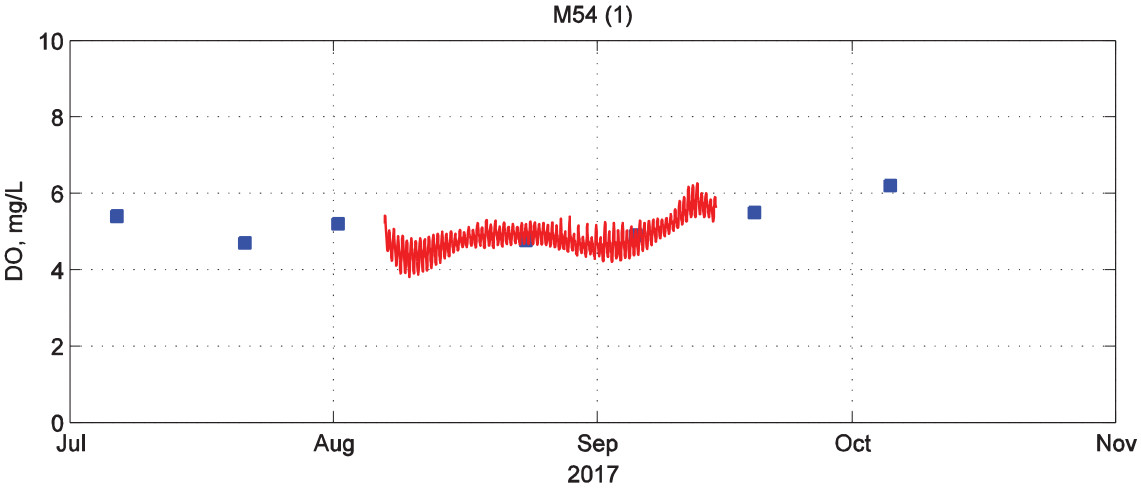

IC (1)

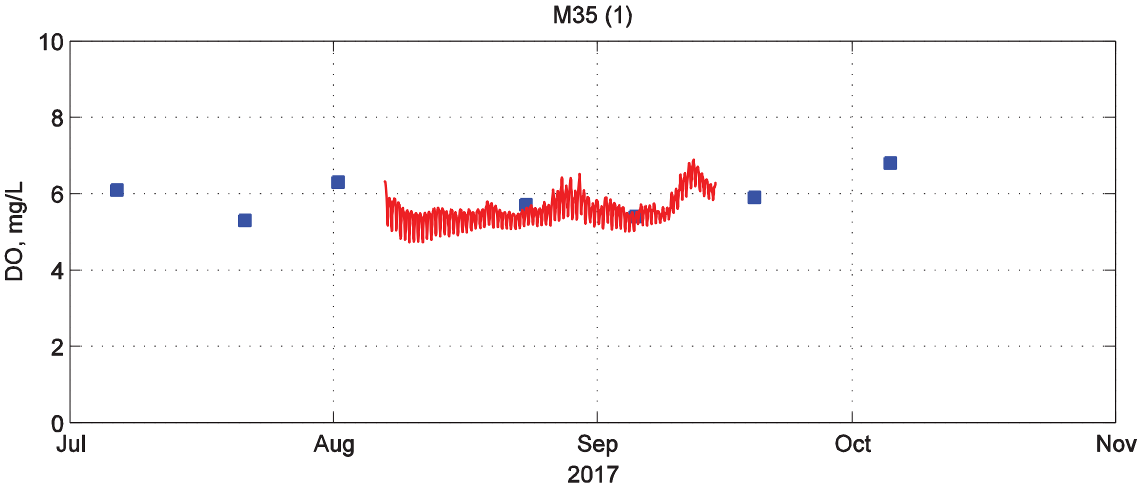

c82 - multi
NAV (1)

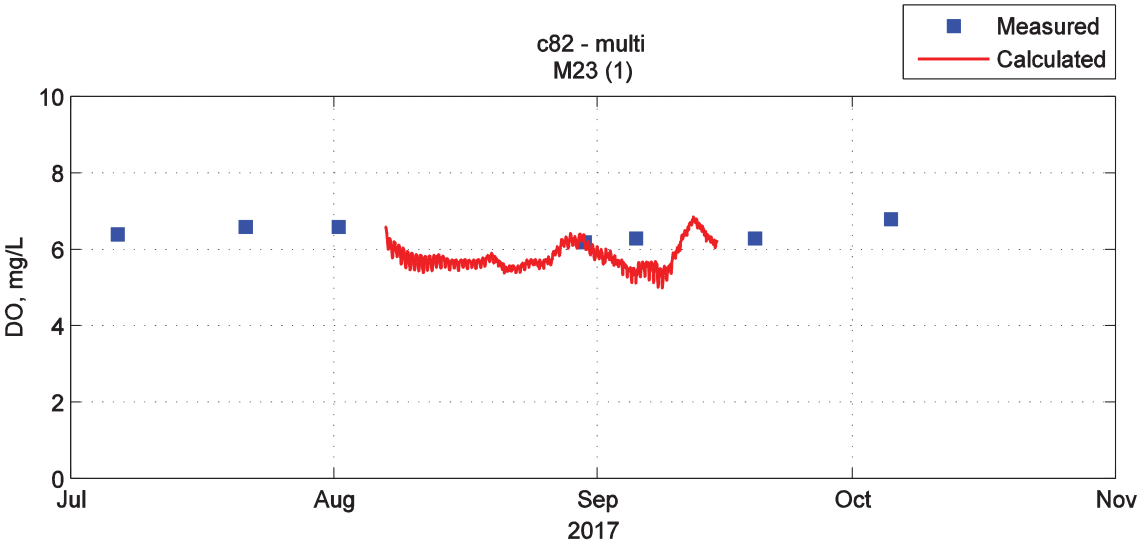

HB (1)

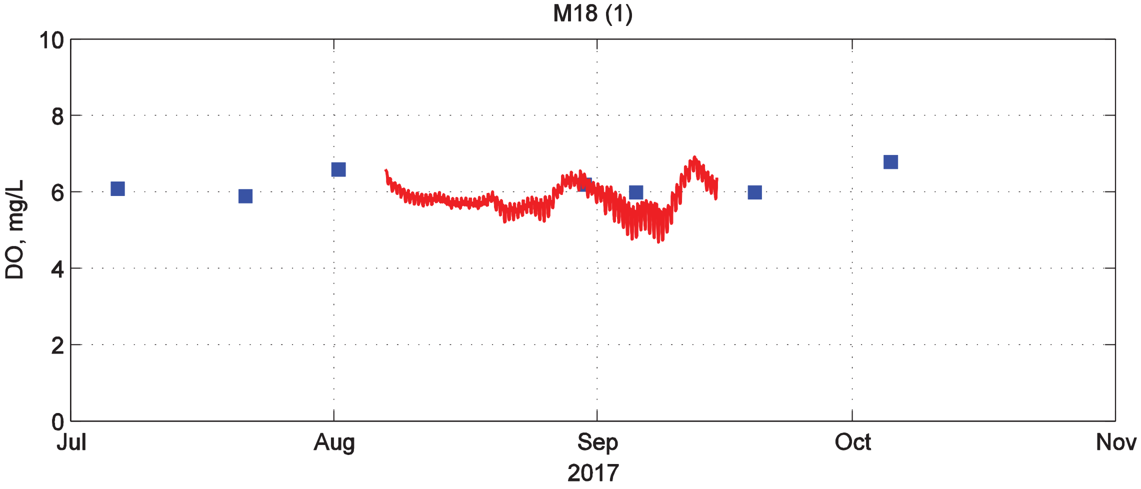

BRR (1)

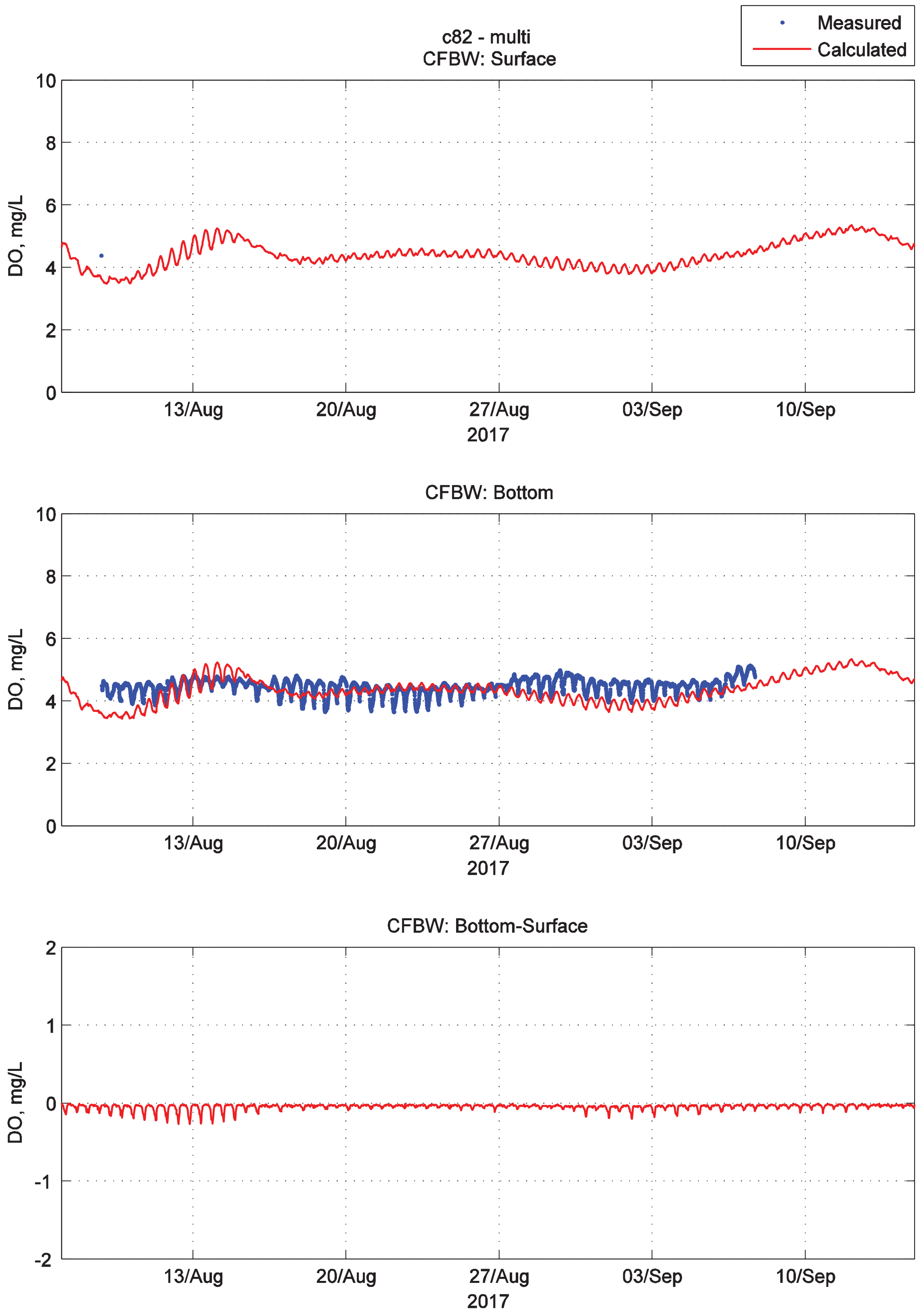

c82 - multi
M61 (1)
Measured
Calculated
DO, mg/L
10
8
6
4
2
0
Jul
Aug
Sep
Oct
Nov
2017

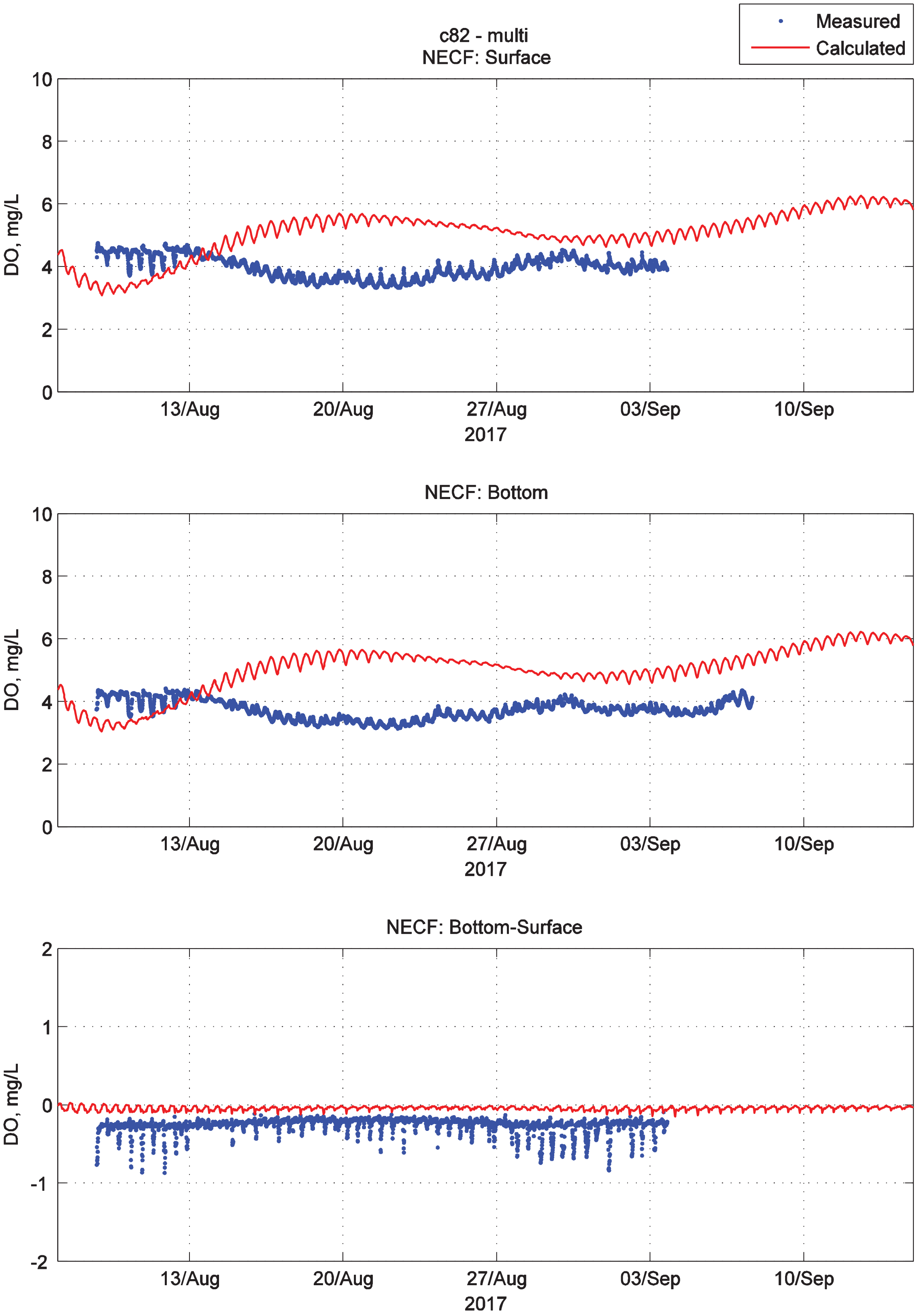

M54 (1)
DO, mg/L
10
8
6
4
2
0
Jul
Aug
Sep
Oct
Nov
2017

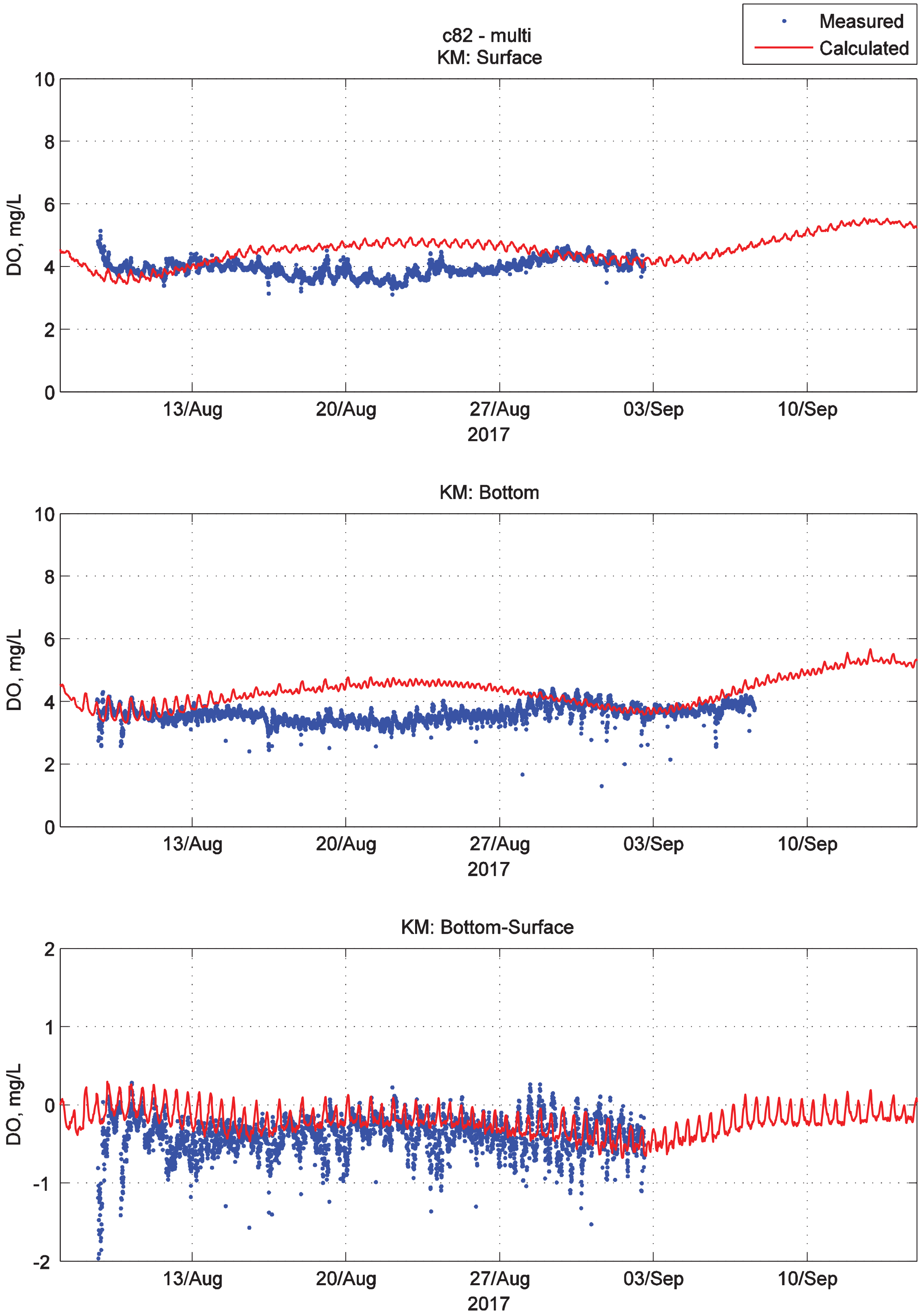

M35 (1)
DO, mg/L
10
8
6
4
2
0
Jul
Aug
Sep
Oct
Nov
2017

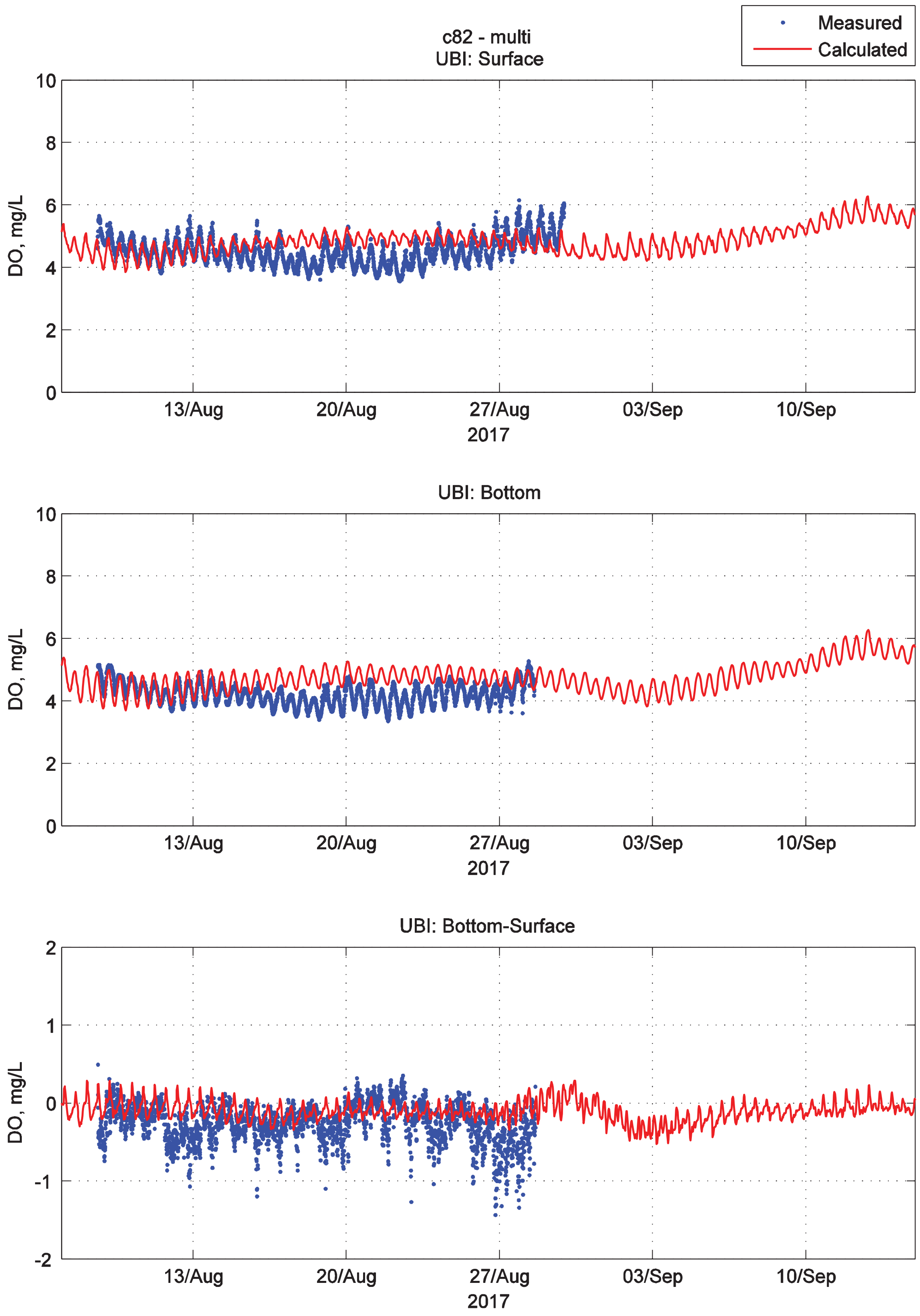

c82 - multi
M23 (1)

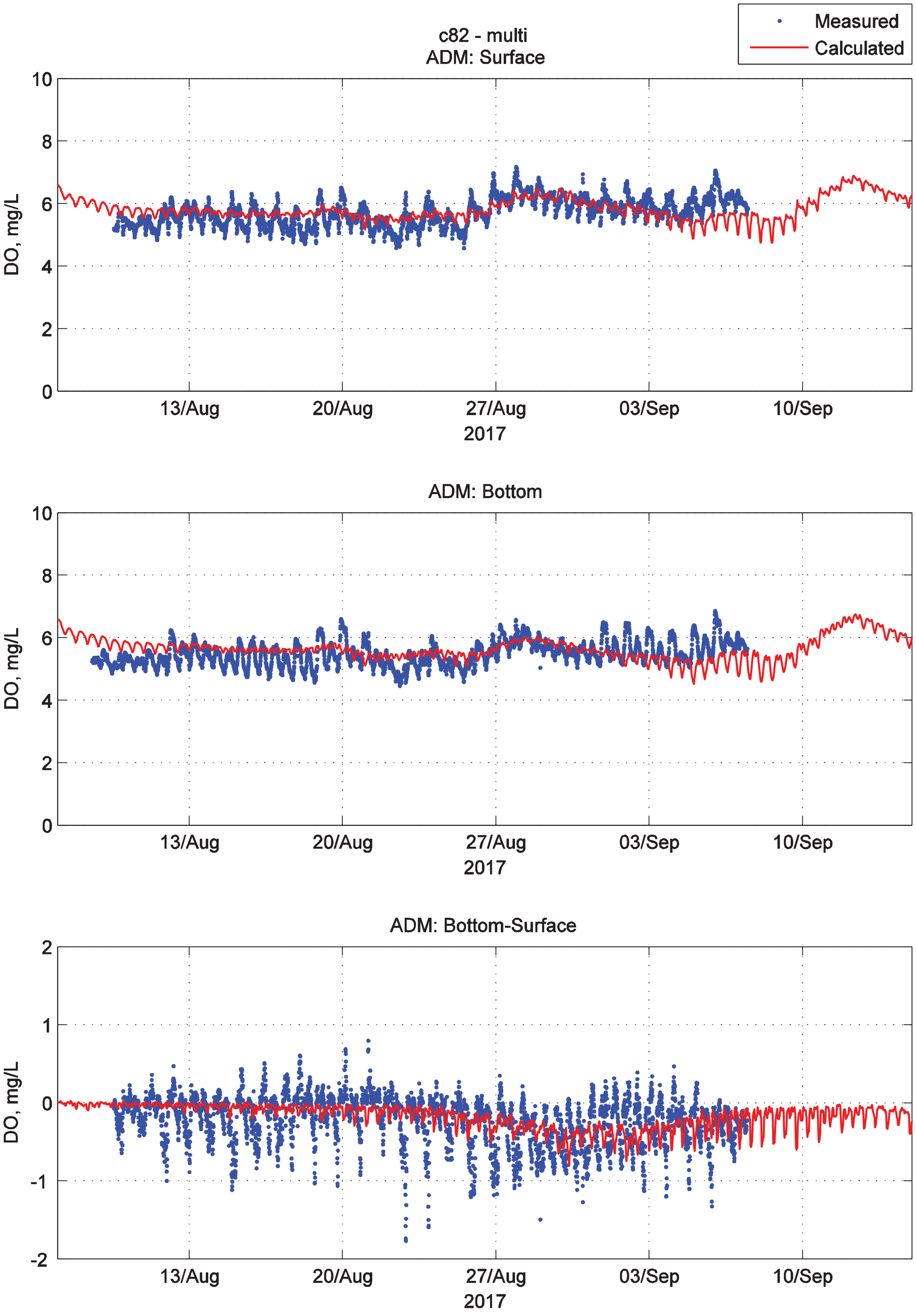

M18 (1)

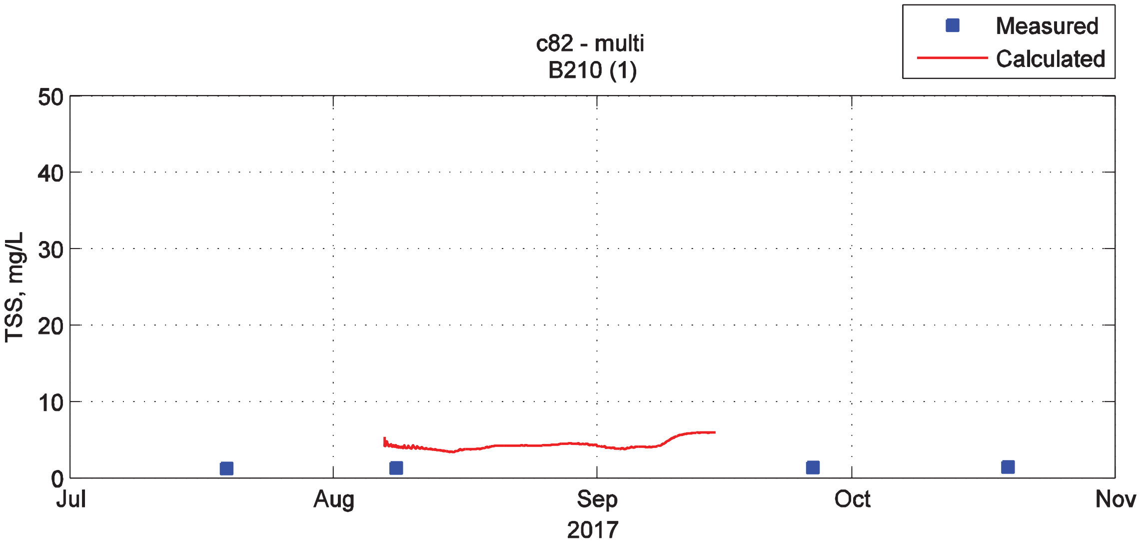

c82 - multi
CFBW: Surface
Measured
Calculated
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW: Bottom
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW: Bottom-Surface
DO, mg/L
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

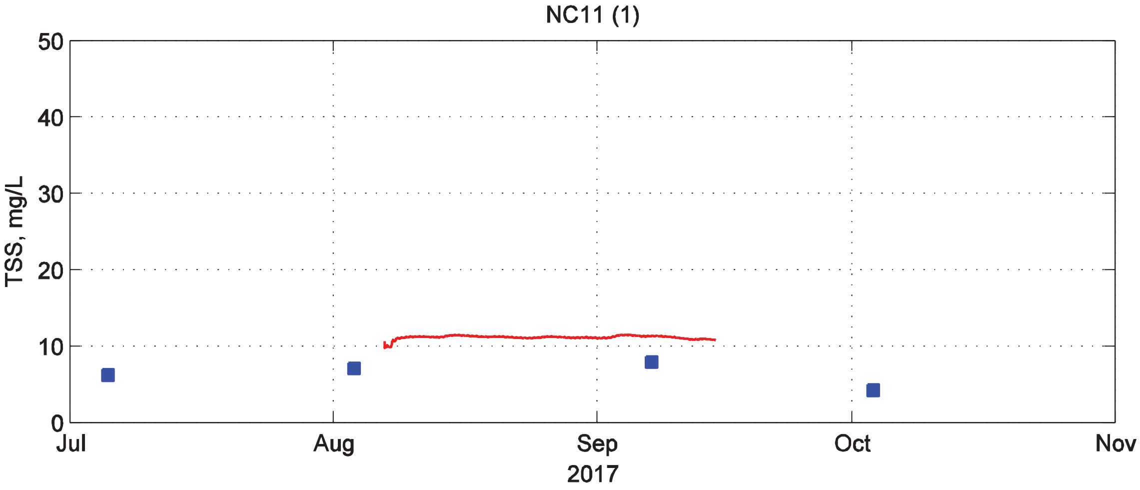

c82 - multi
NECF: Surface
Measured
Calculated
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF: Bottom
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF: Bottom-Surface
DO, mg/L
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

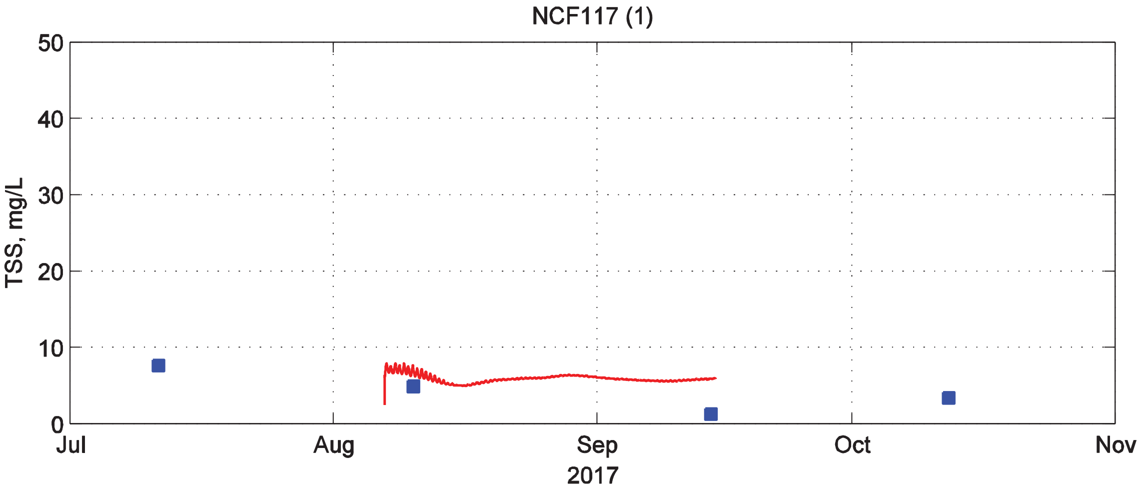

Measured
Calculated
c82 - multi
KM: Surface
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM: Bottom
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM: Bottom-Surface
DO, mg/L
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

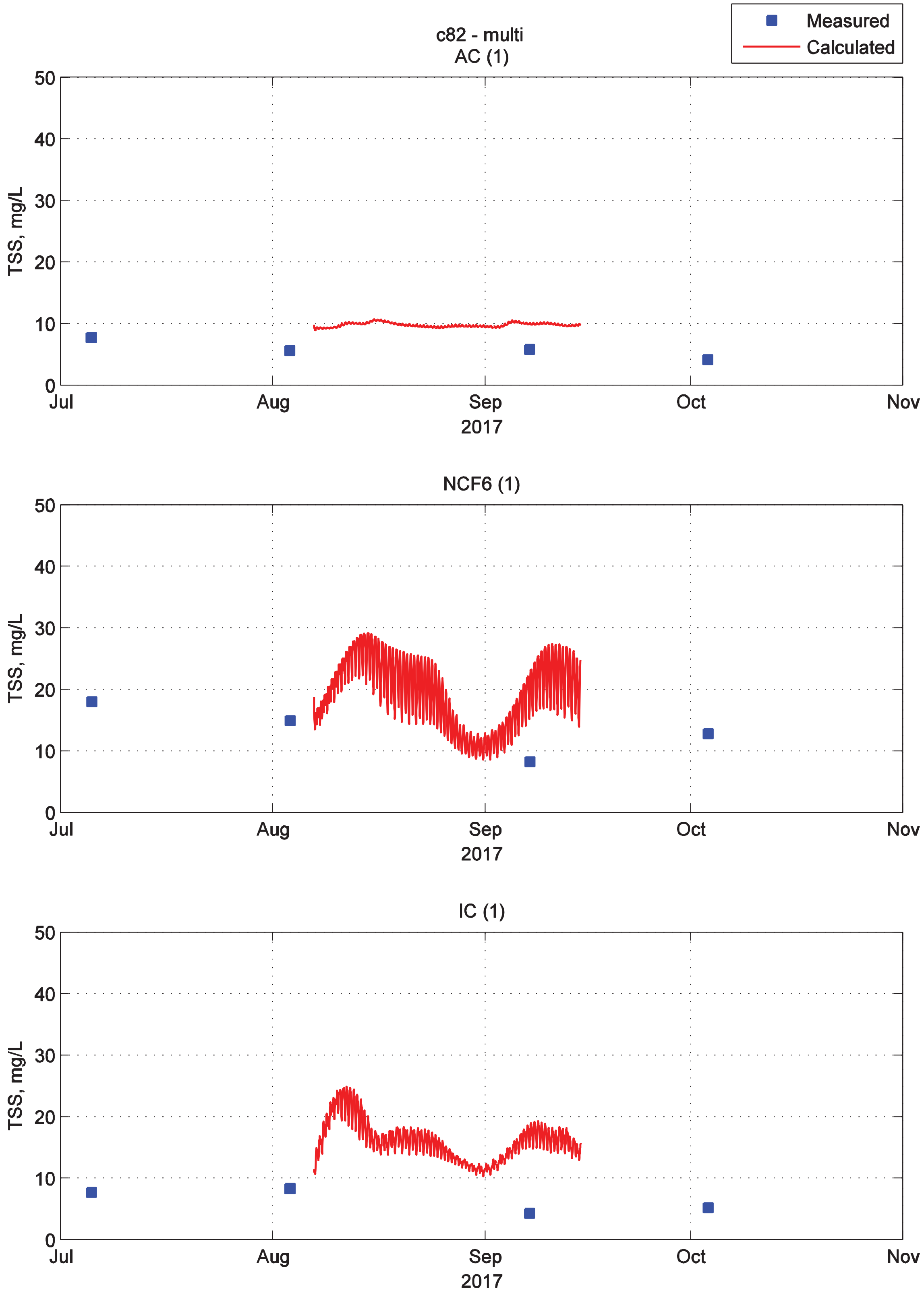

Measured
Calculated
c82 - multi
UBI: Surface
10
8
6
4
2
0
DO, mg/L
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI: Bottom
10
8
6
4
2
0
DO, mg/L
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI: Bottom-Surface
2
1
0
-1
-2
DO, mg/L
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

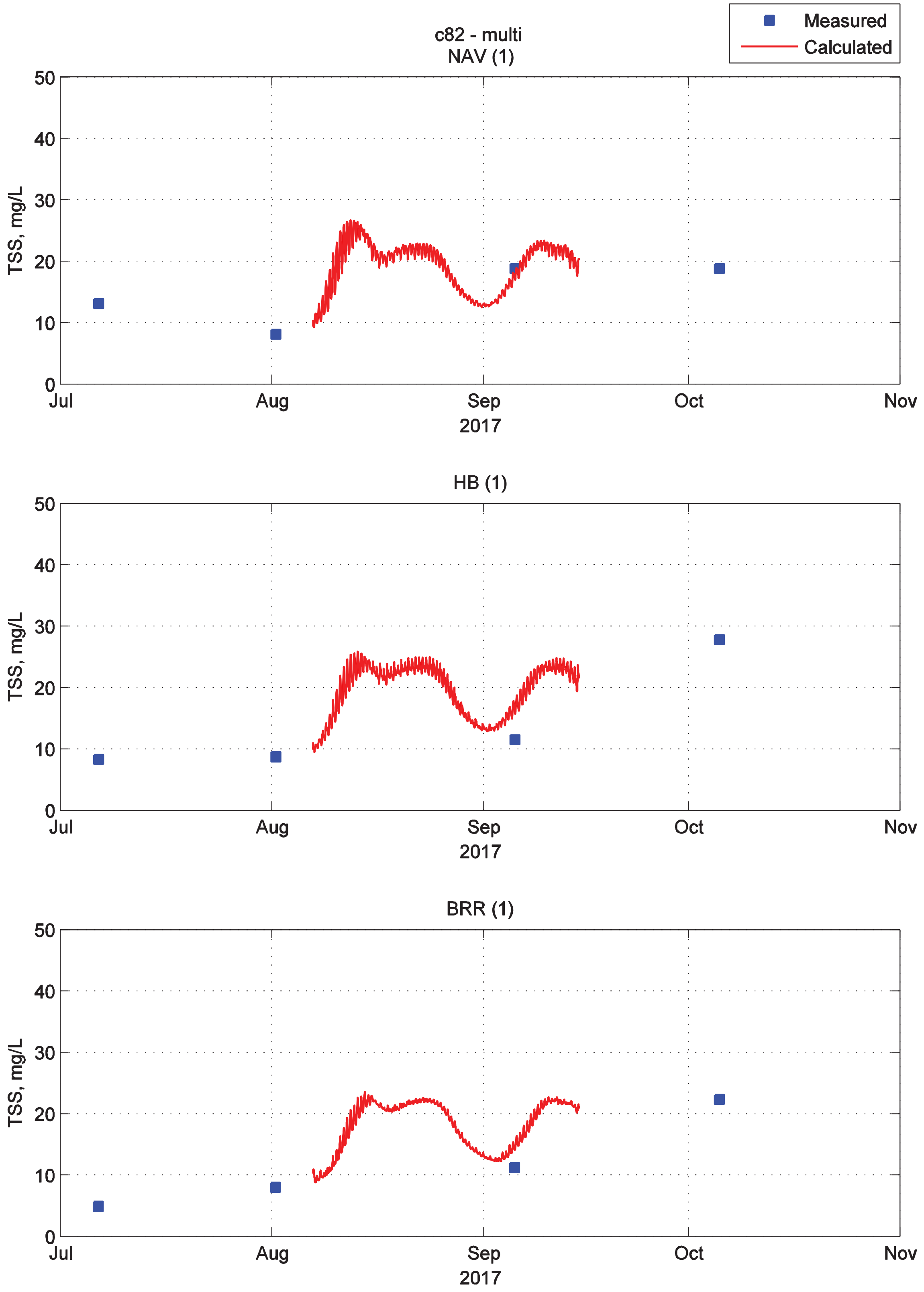

Measured
Calculated
c82 - multi
ADM: Surface
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
ADM: Bottom
DO, mg/L
10
8
6
4
2
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
ADM: Bottom-Surface
DO, mg/L
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

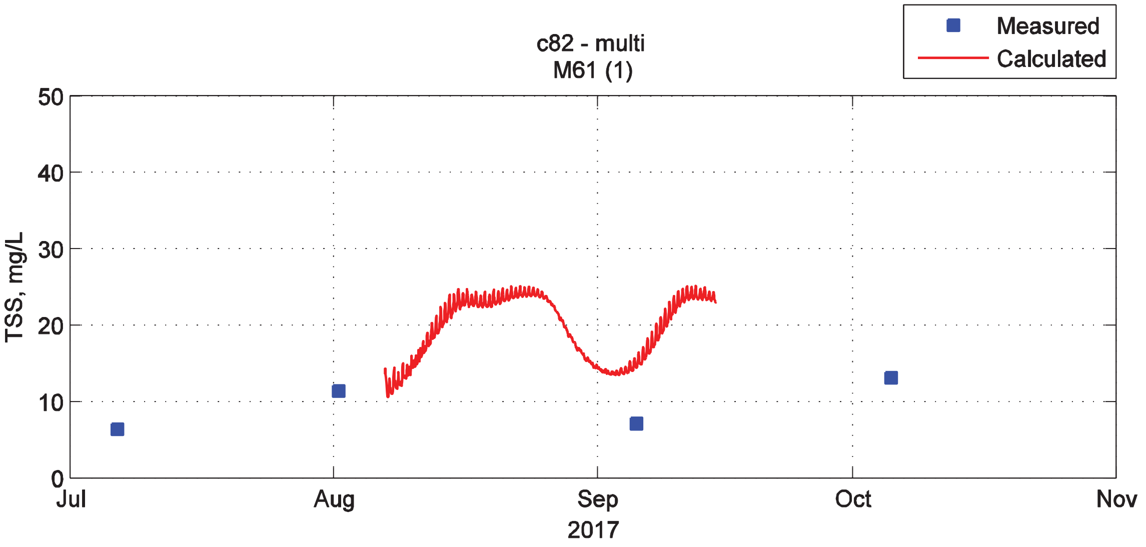

Measured
Calculated
c82 - multi
B210 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

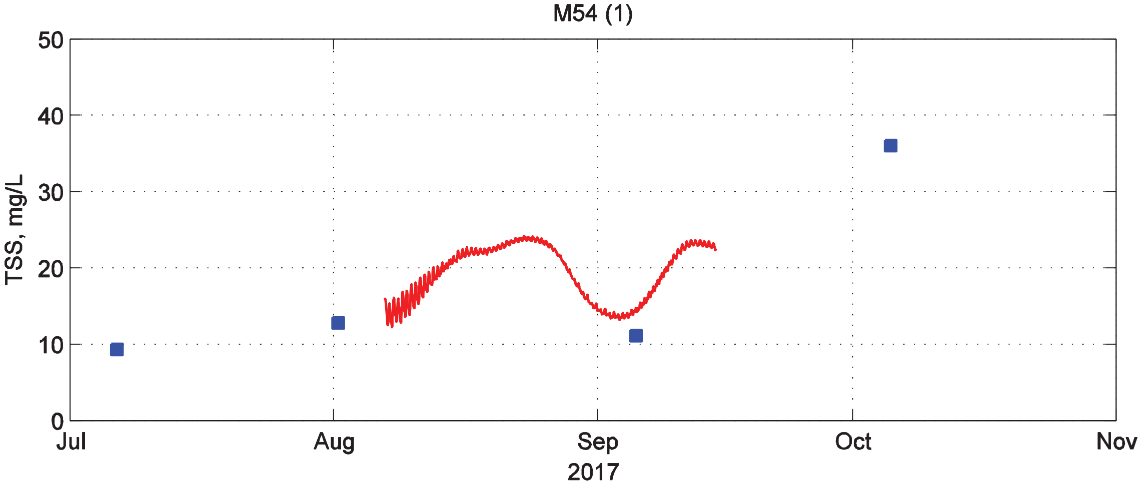

NC11 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

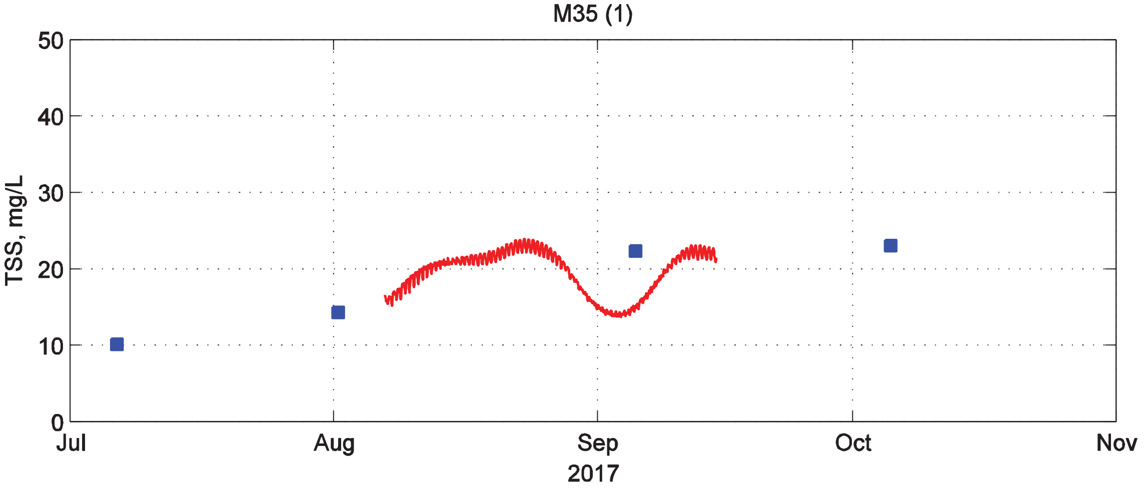

NCF117 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

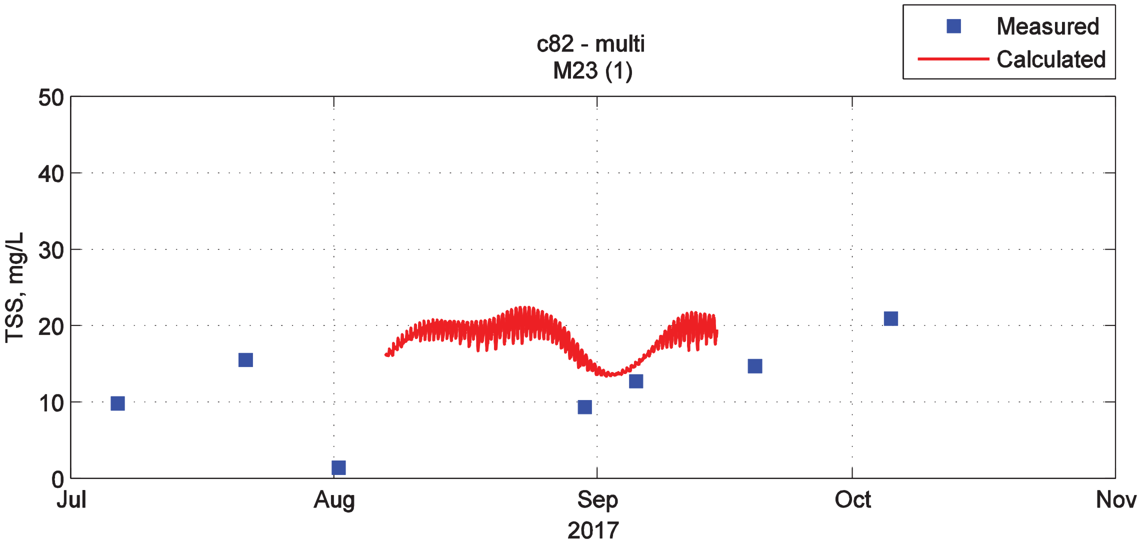

■ Measured
— Calculated
c82 - multi
AC (1)
TSS, mg/L
0
10
20
30
40
50
Jul
Aug
Sep
Oct
Nov
2017
NCF6 (1)
TSS, mg/L
0
10
20
30
40
50
Jul
Aug
Sep
Oct
Nov
2017
IC (1)
TSS, mg/L
0
10
20
30
40
50
Jul
Aug
Sep
Oct
Nov
2017

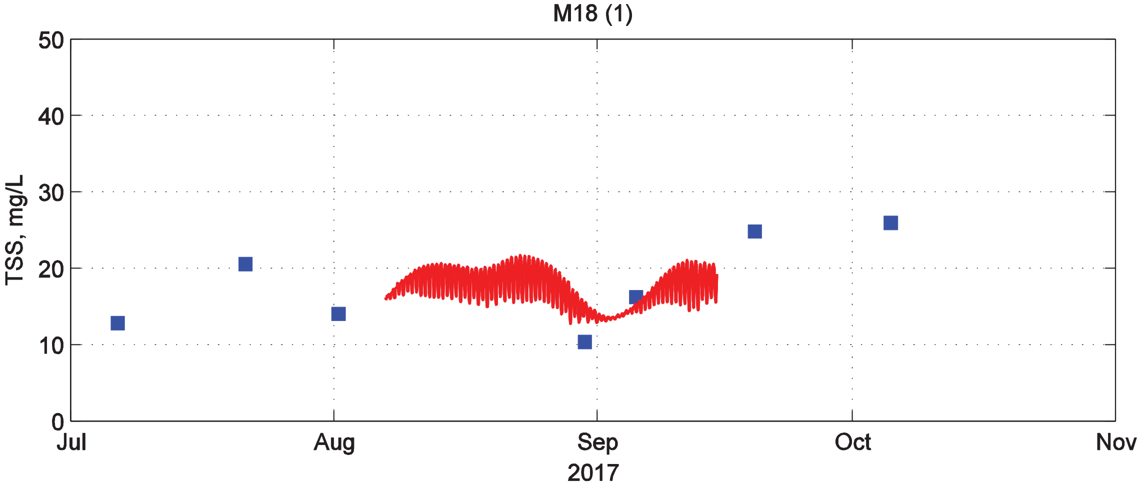

■ Measured
— Calculated
c82 - multi
NAV (1)
TSS, mg/L
0
10
20
30
40
50
Jul
Aug
Sep
Oct
Nov
2017
HB (1)
TSS, mg/L
0
10
20
30
40
50
Jul
Aug
Sep
Oct
Nov
2017
BRR (1)
TSS, mg/L
0
10
20
30
40
50
Jul
Aug
Sep
Oct
Nov
2017

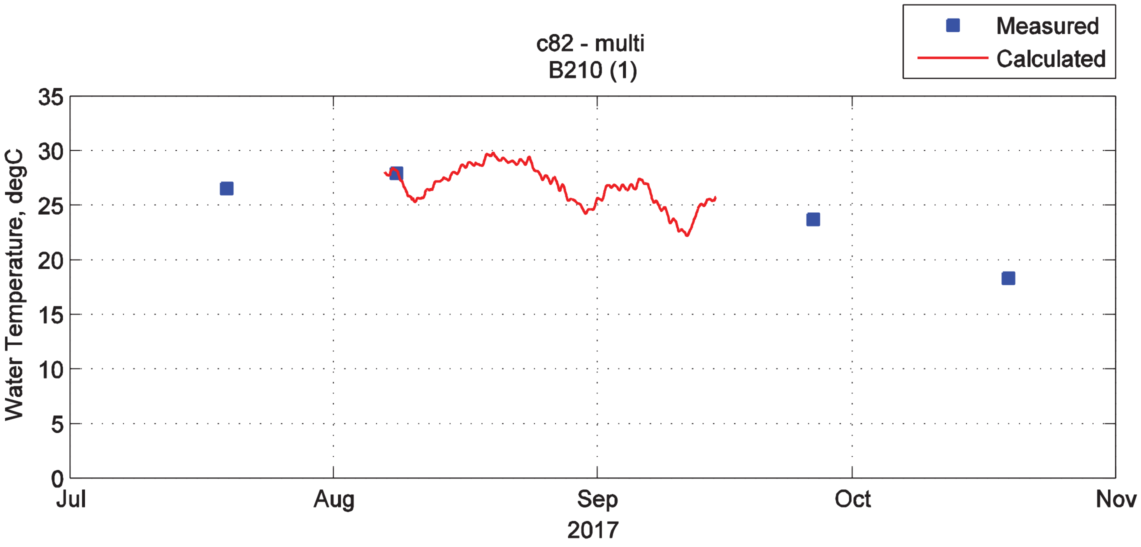

Measured
Calculated
c82 - multi
M61 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

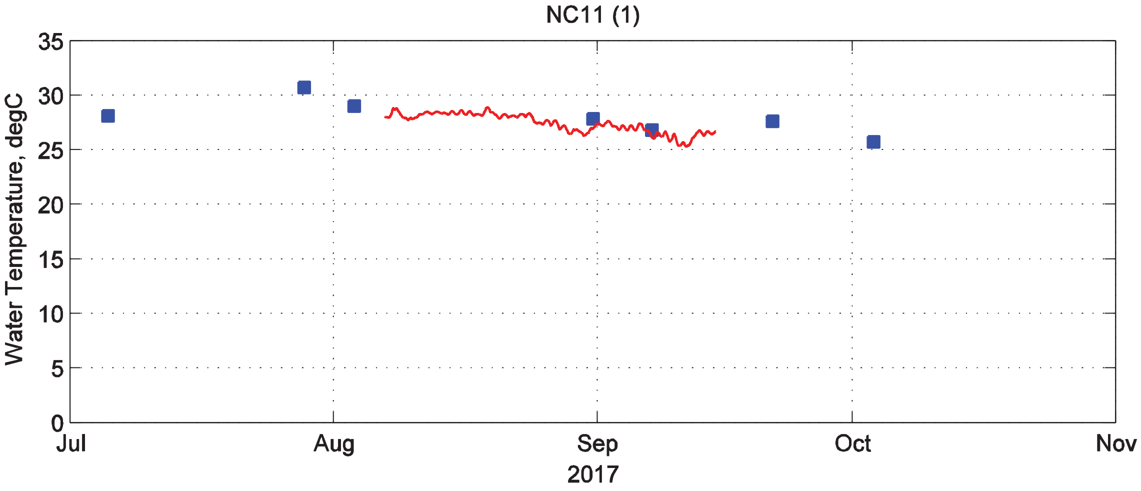

M54 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

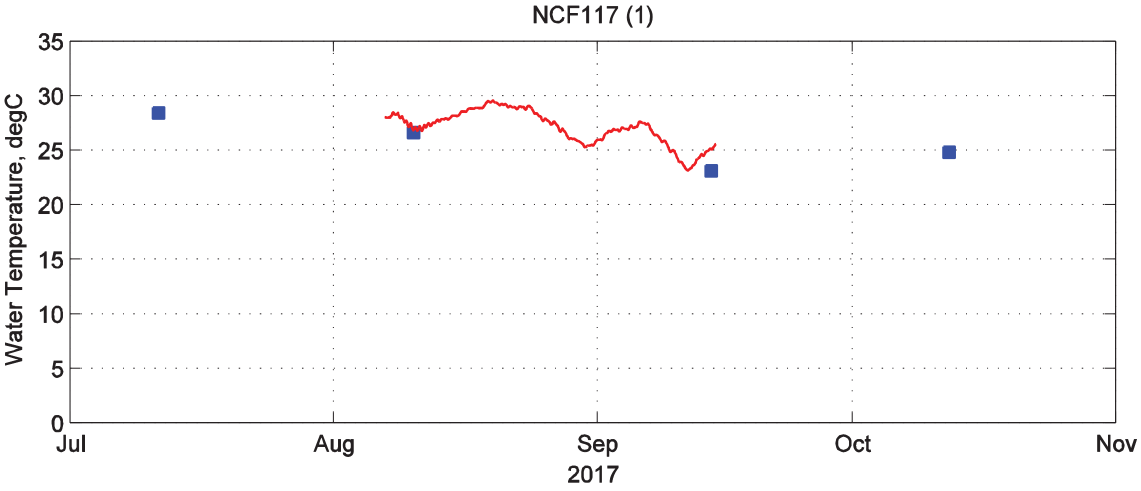

M35 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

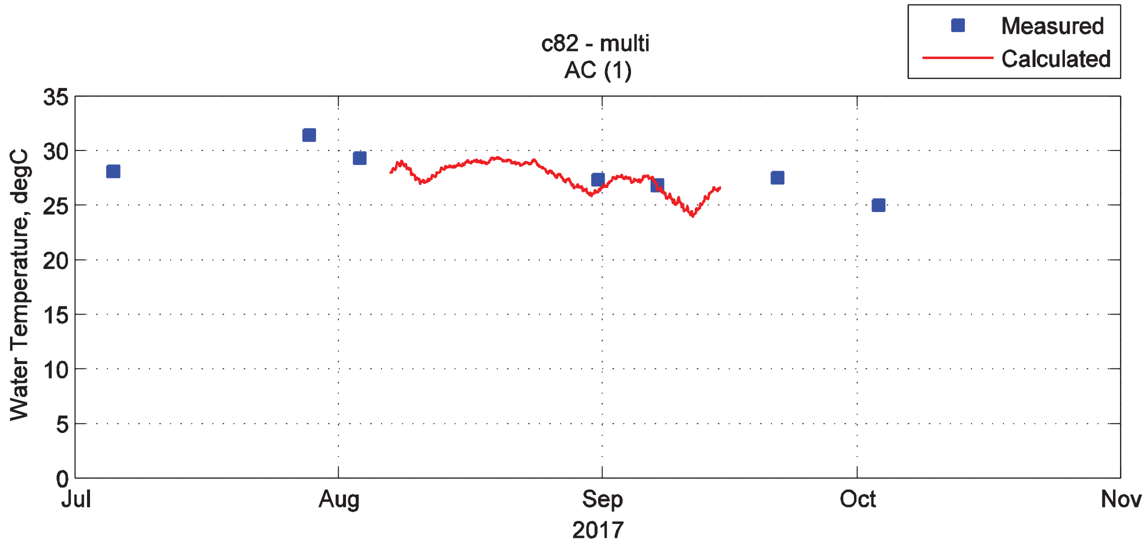

■ Measured
— Calculated
c82 - multi
M23 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

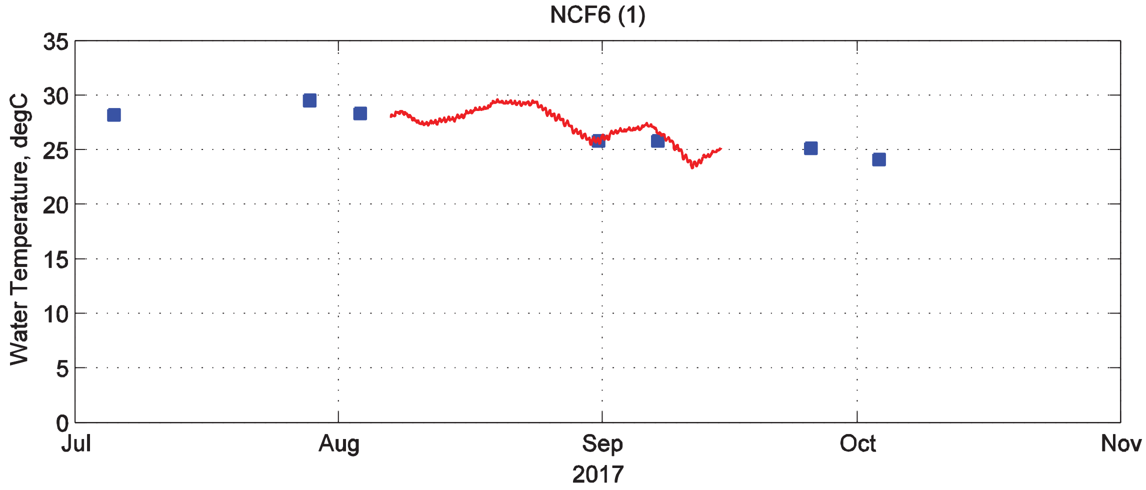

M18 (1)
TSS, mg/L
50
40
30
20
10
0
Jul
Aug
Sep
Oct
Nov
2017

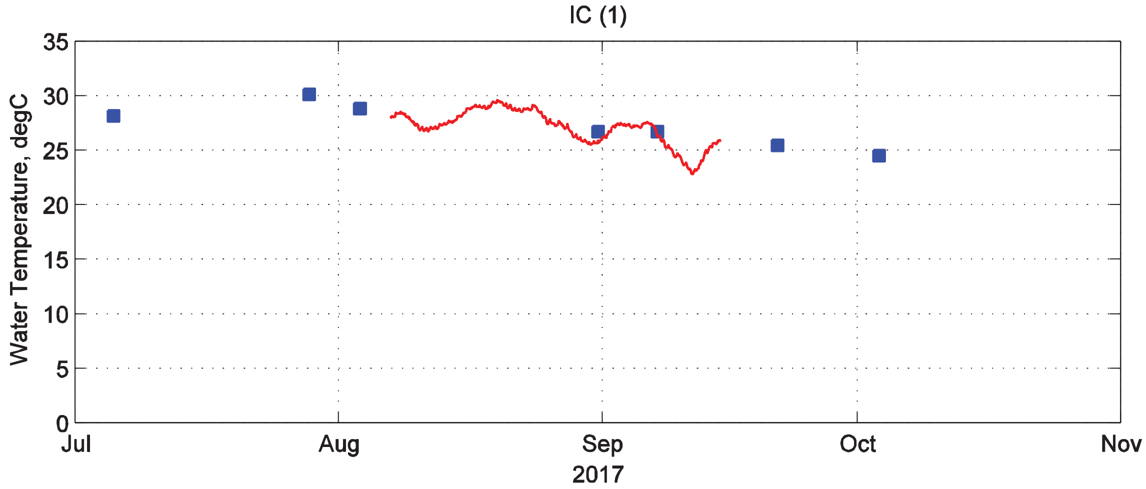

c82 - multi
B210 (1)
Measured
Calculated
Water Temperature, degC
0
5
10
15
20
25
30
35
Jul
Aug
Sep
Oct
Nov
2017

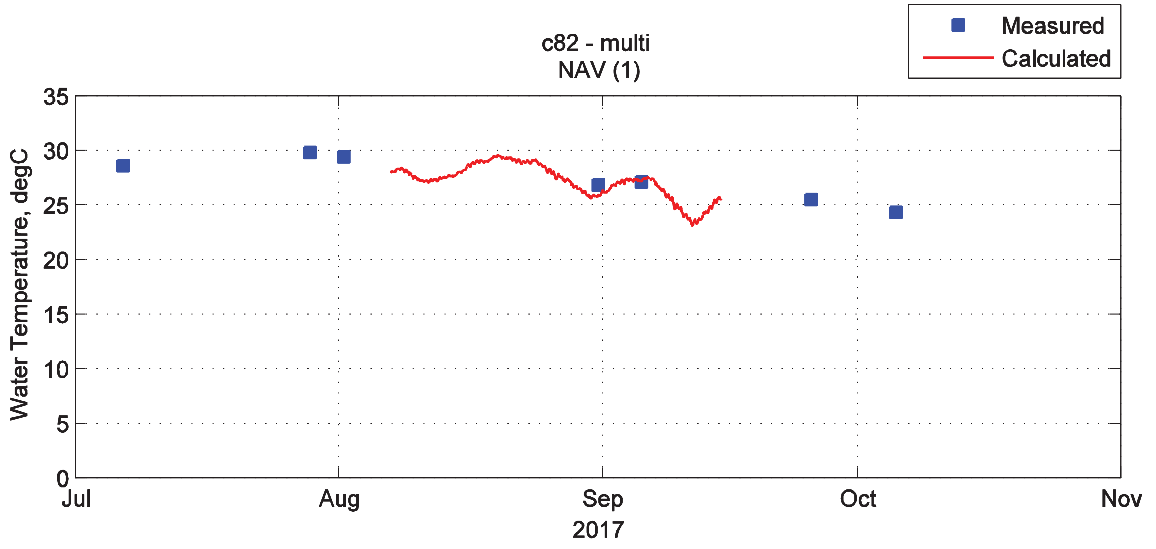

NC11 (1)
Water Temperature, degC
0
5
10
15
20
25
30
35
Jul
Aug
Sep
Oct
Nov
2017

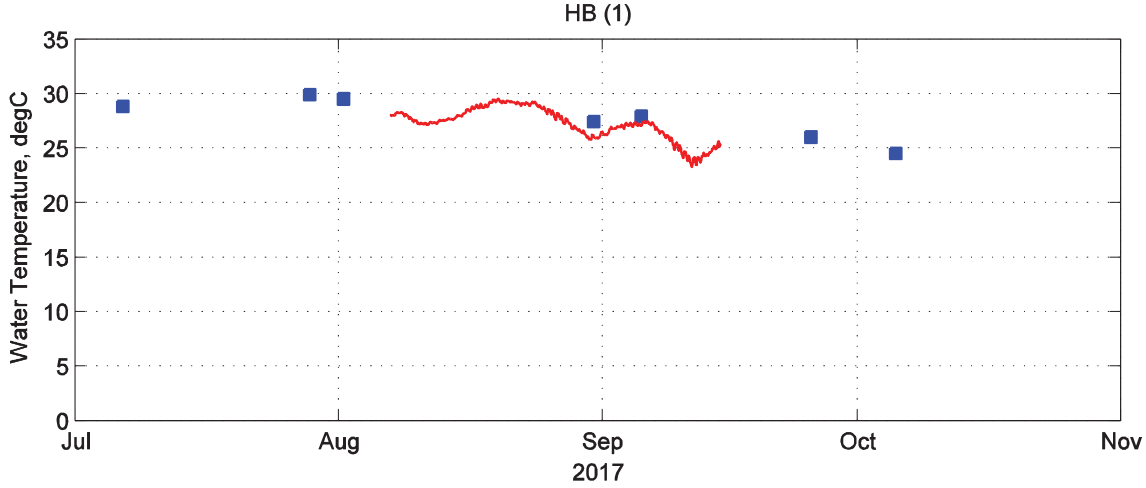

NCF117 (1)
Water Temperature, degC
0
5
10
15
20
25
30
35
Jul
Aug
Sep
Oct
Nov
2017

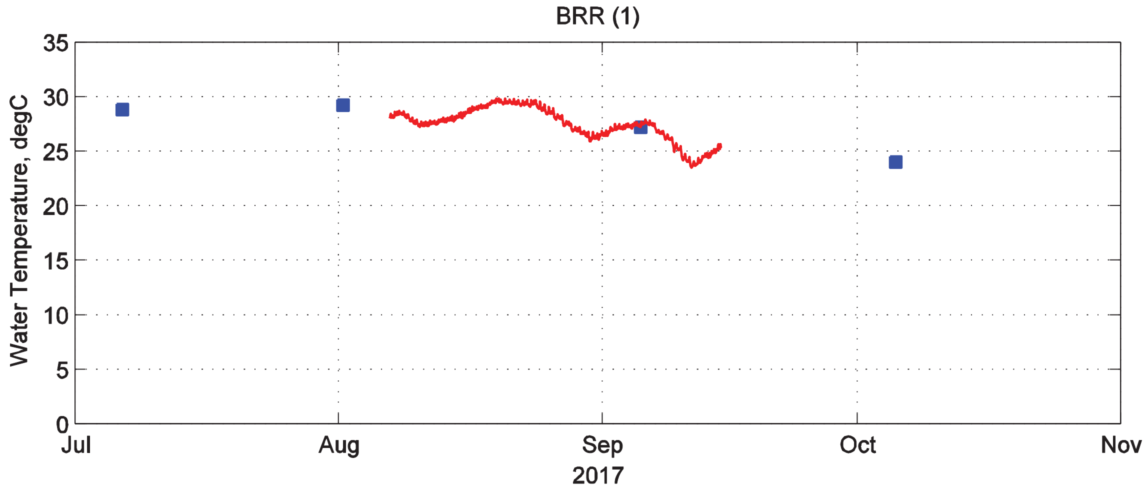

c82 - multi
AC (1)

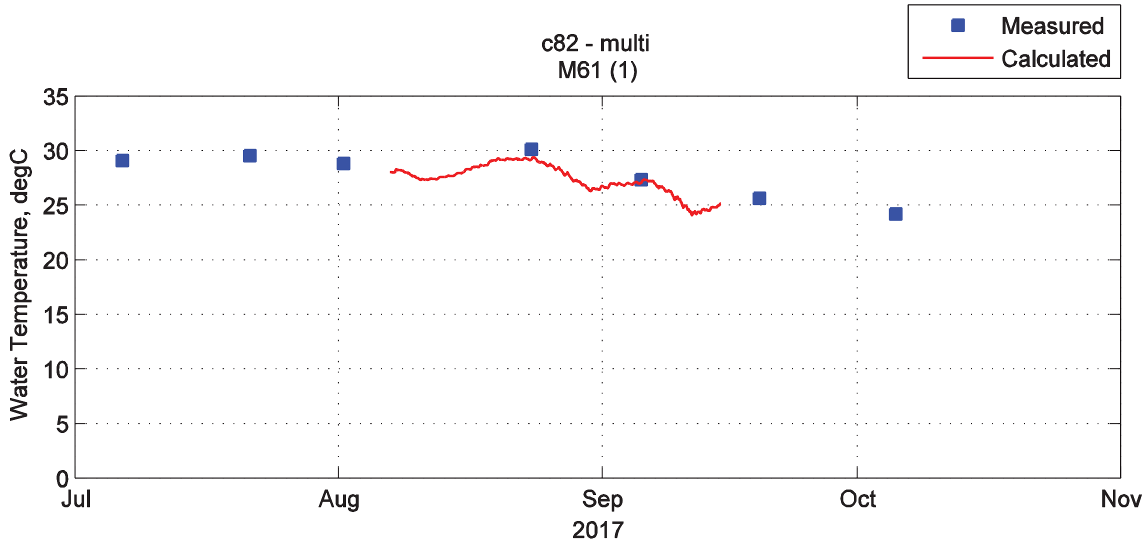

NCF6 (1)

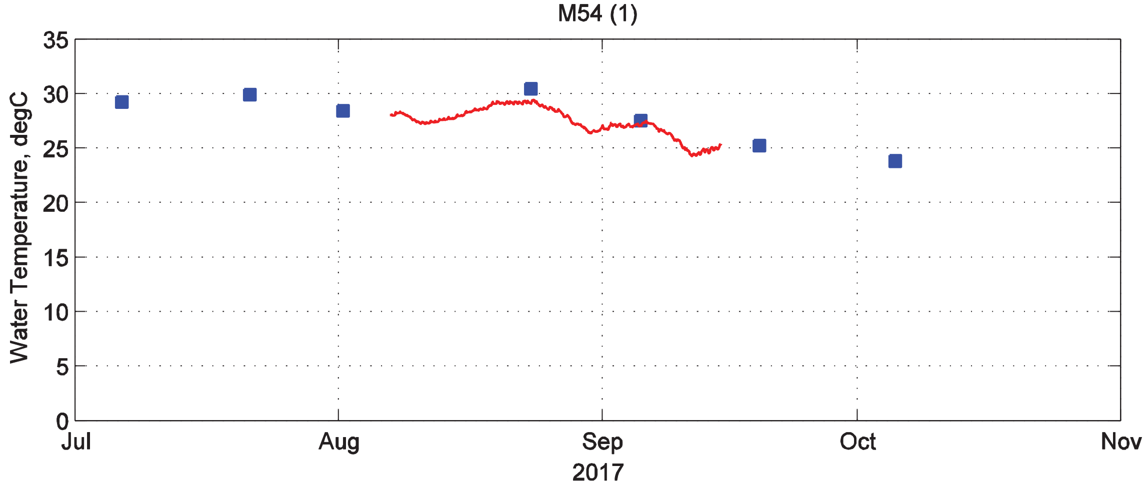

IC (1)

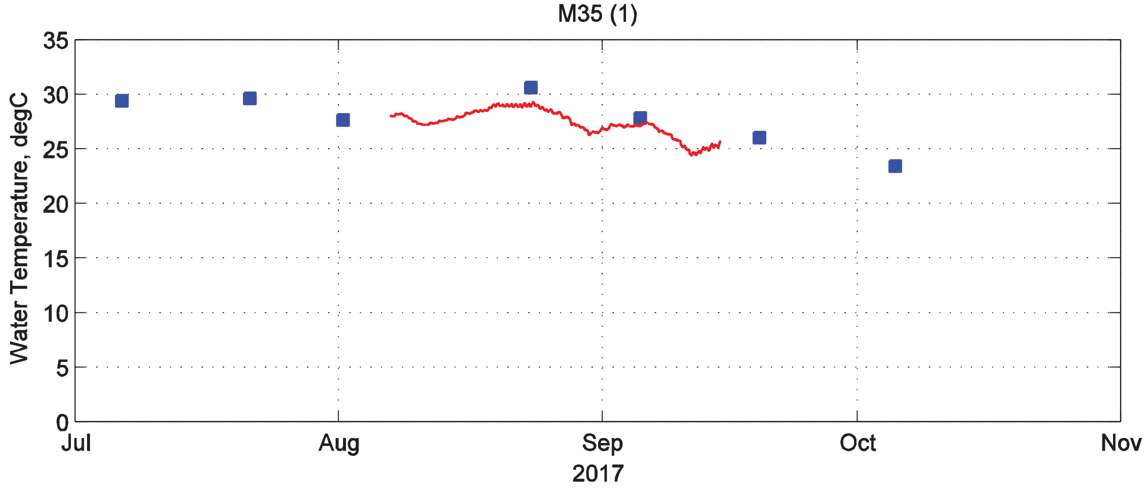

c82 - multi
NAV (1)

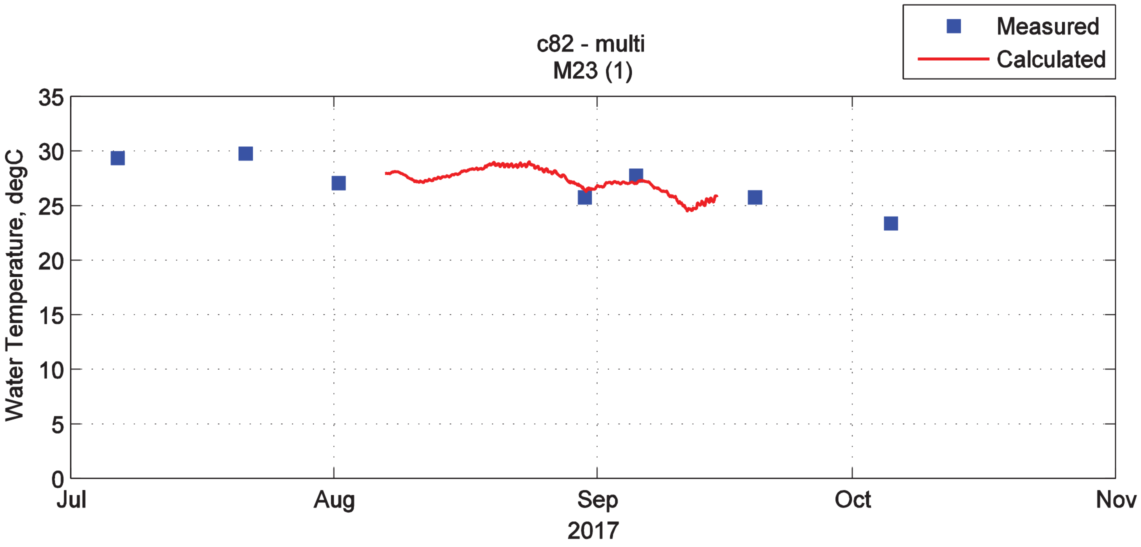

HB (1)

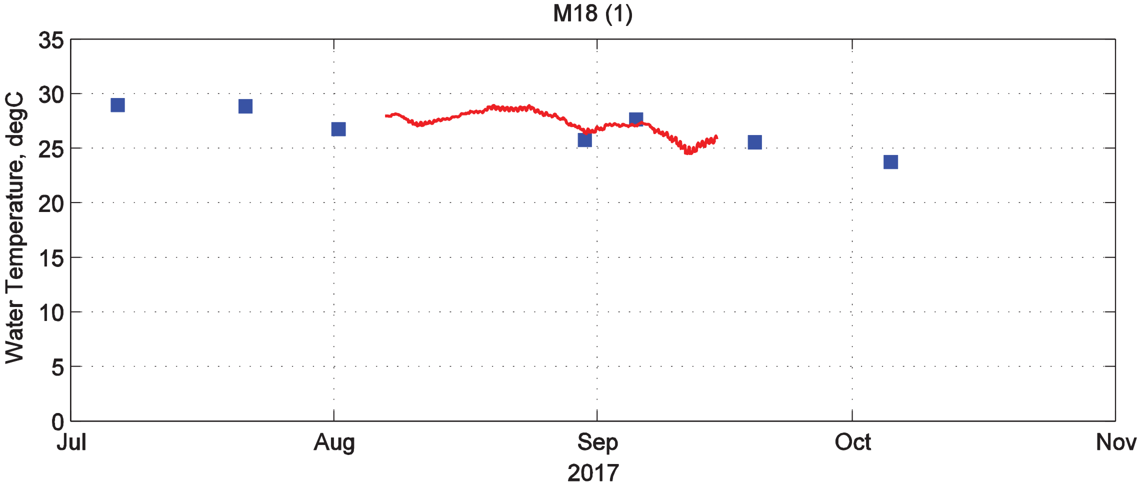

BRR (1)

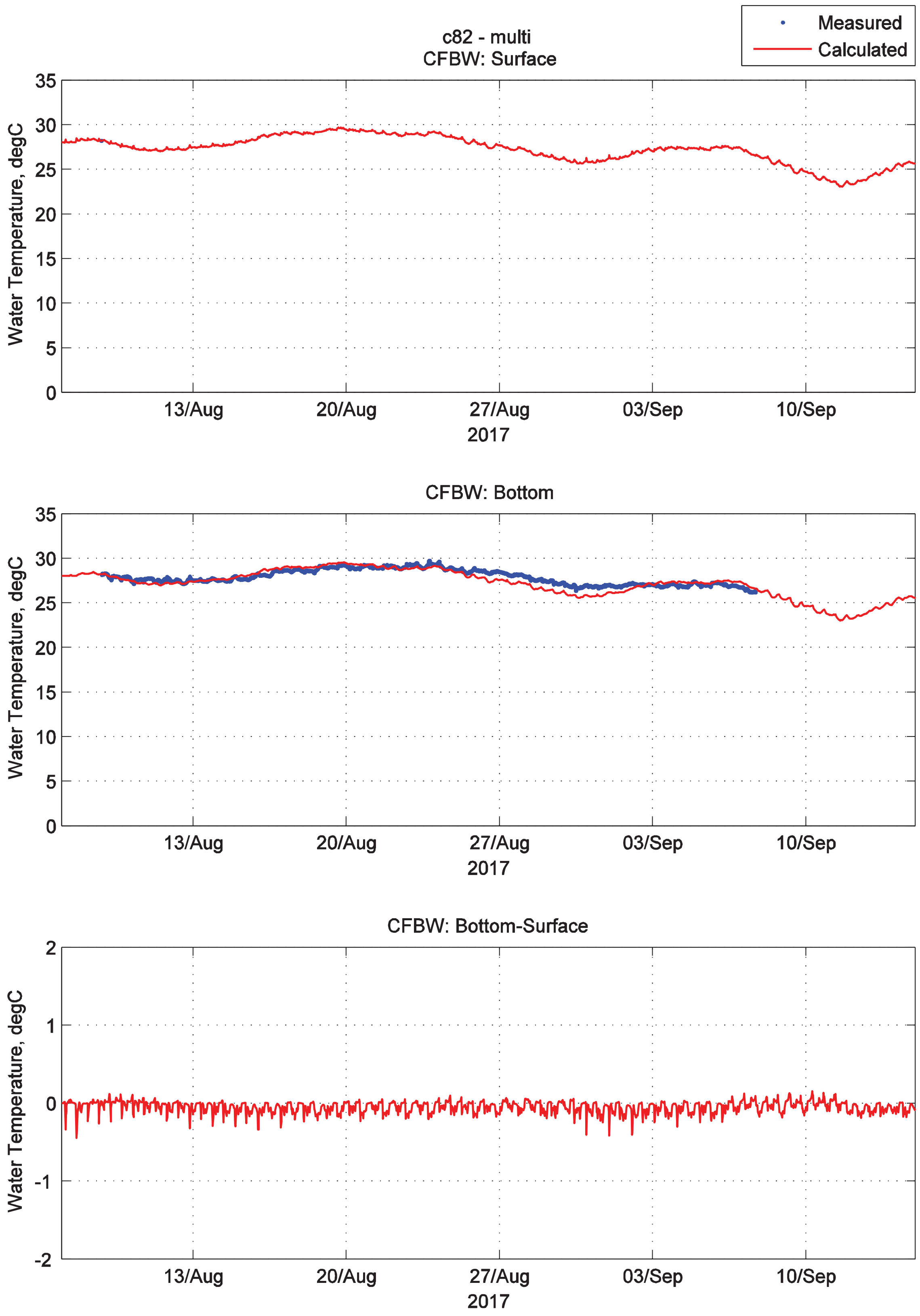

Measured
Calculated
c82 - multi
M61 (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

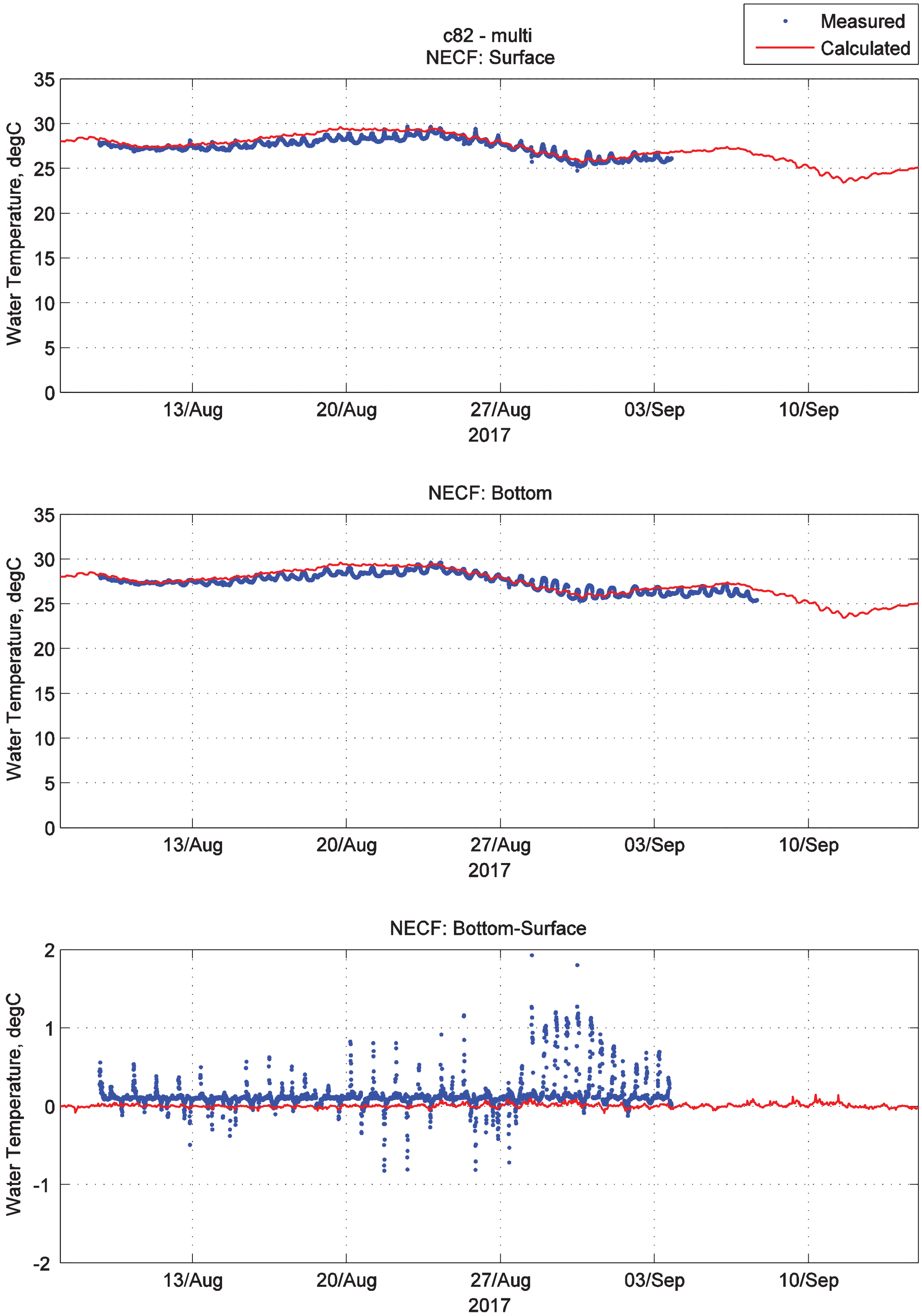

M54 (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

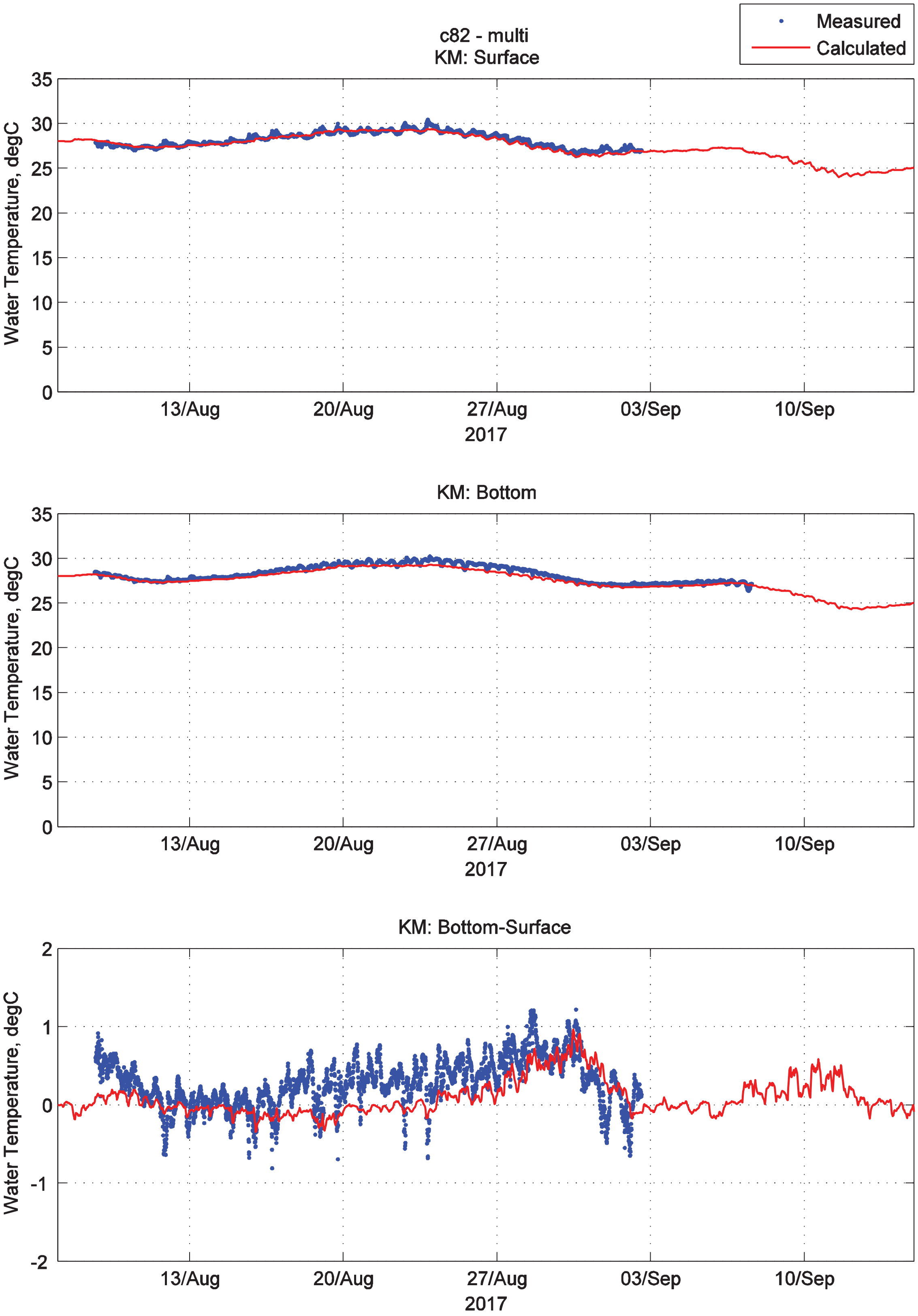

M35 (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

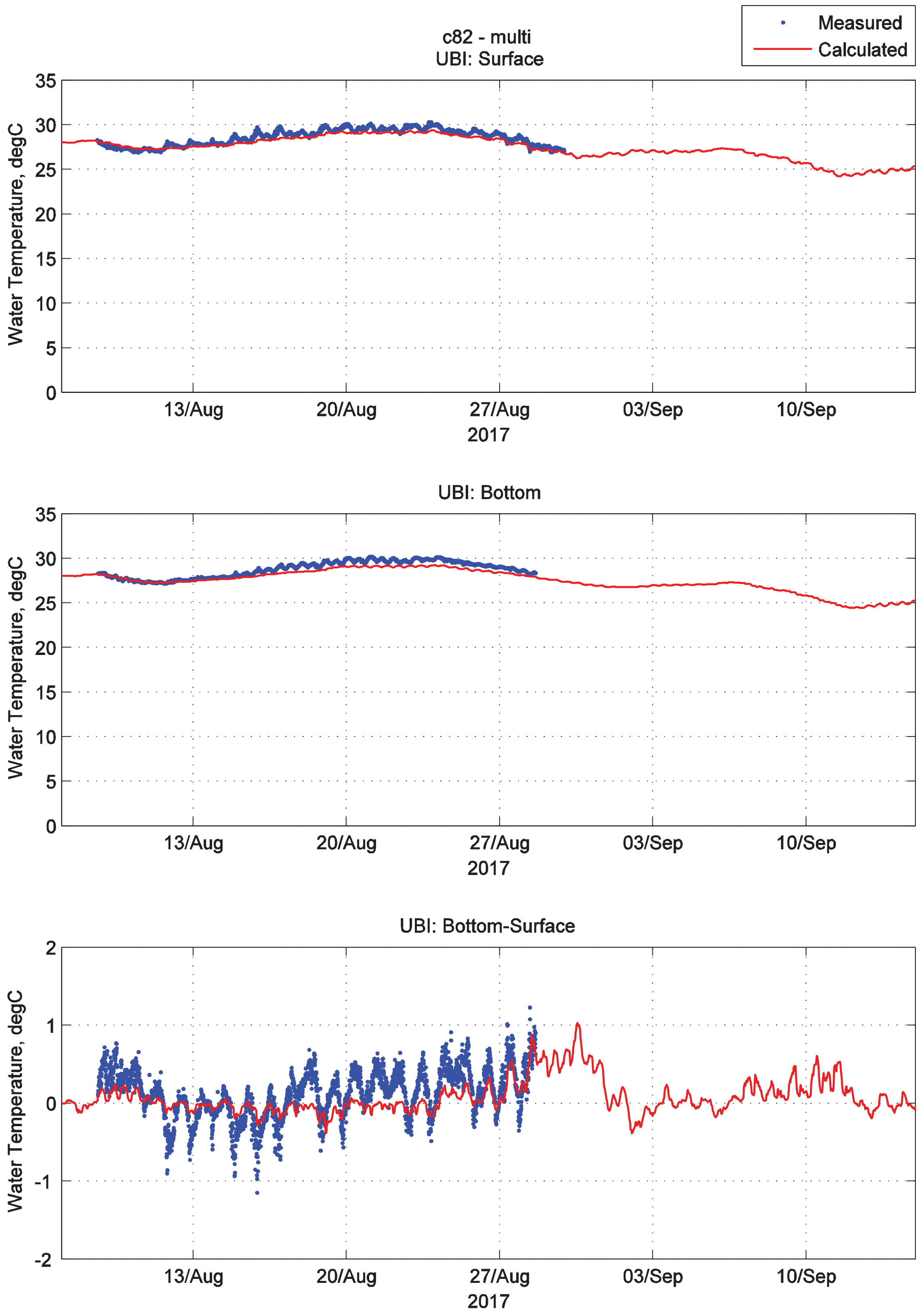

c82 - multi
M23 (1)
Measured
Calculated
Water Temperature, degC
35
30
25
20
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017

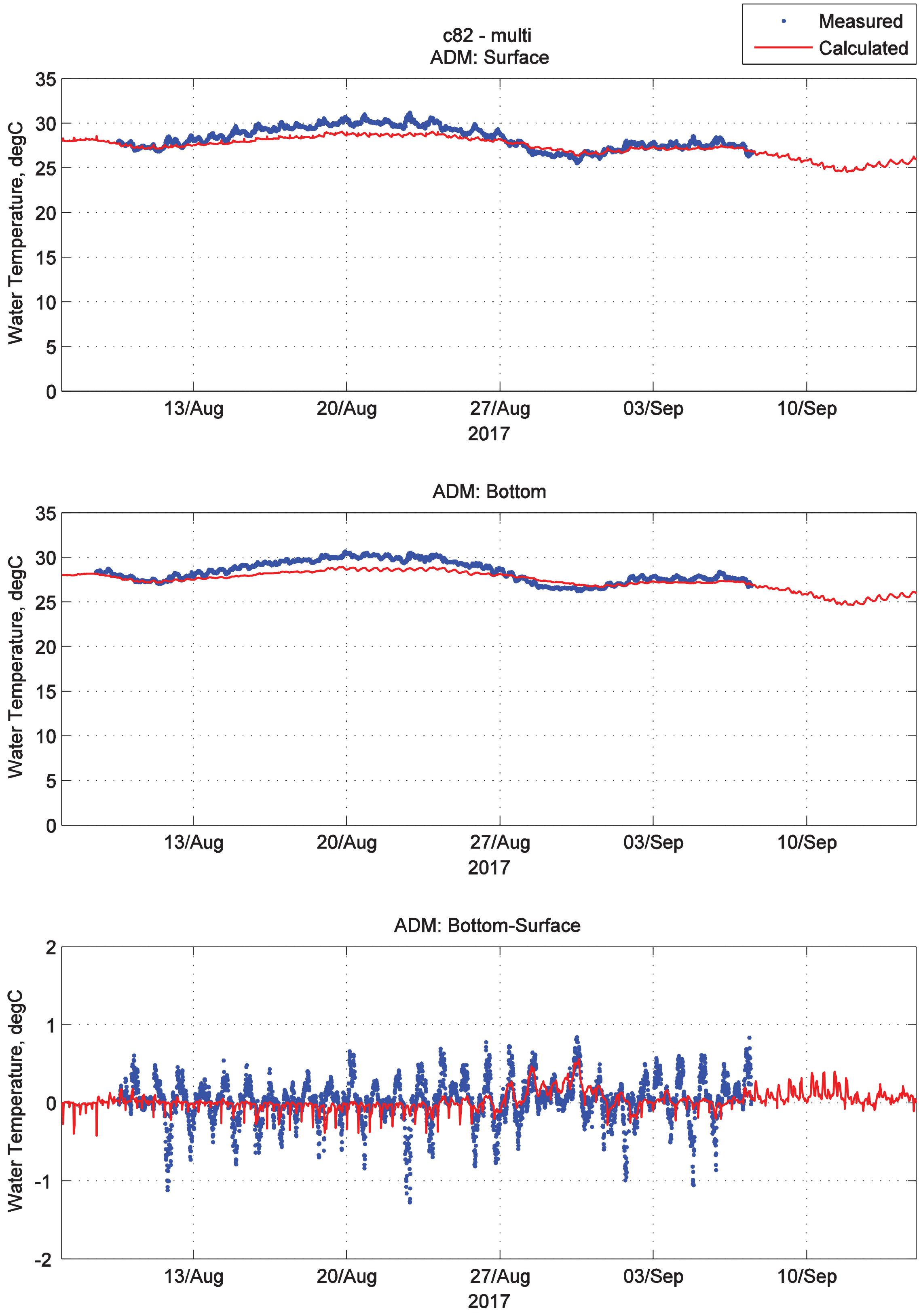

M18 (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
Jul
Aug
Sep
Oct
Nov
2017


Measured
Calculated
c82 - multi
CFBW: Surface
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW: Bottom
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
CFBW: Bottom-Surface
Water Temperature, degC
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

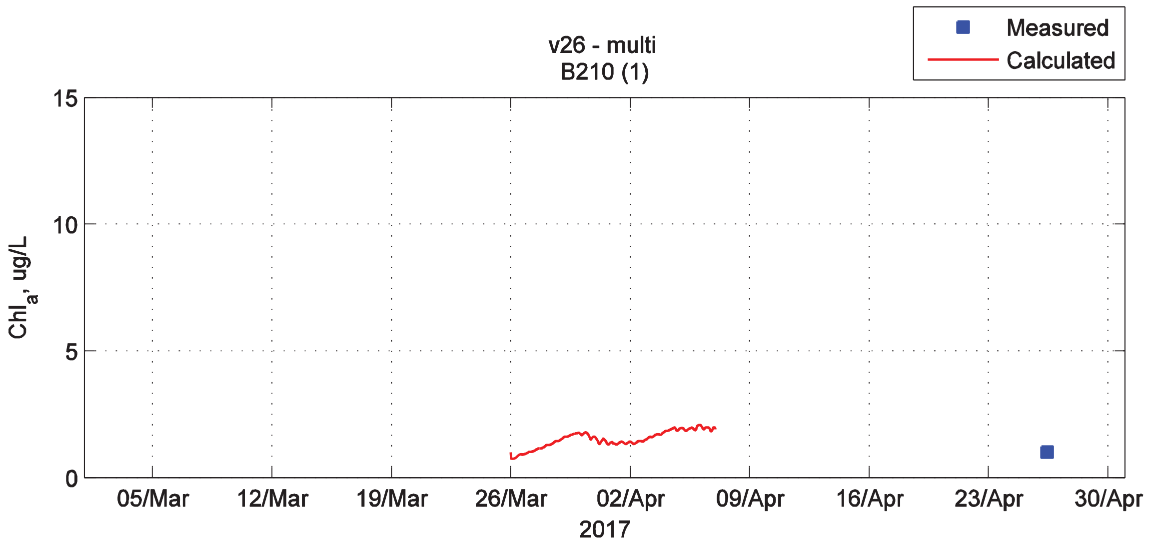

Measured
Calculated
c82 - multi
NECF: Surface
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF: Bottom
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
NECF: Bottom-Surface
Water Temperature, degC
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

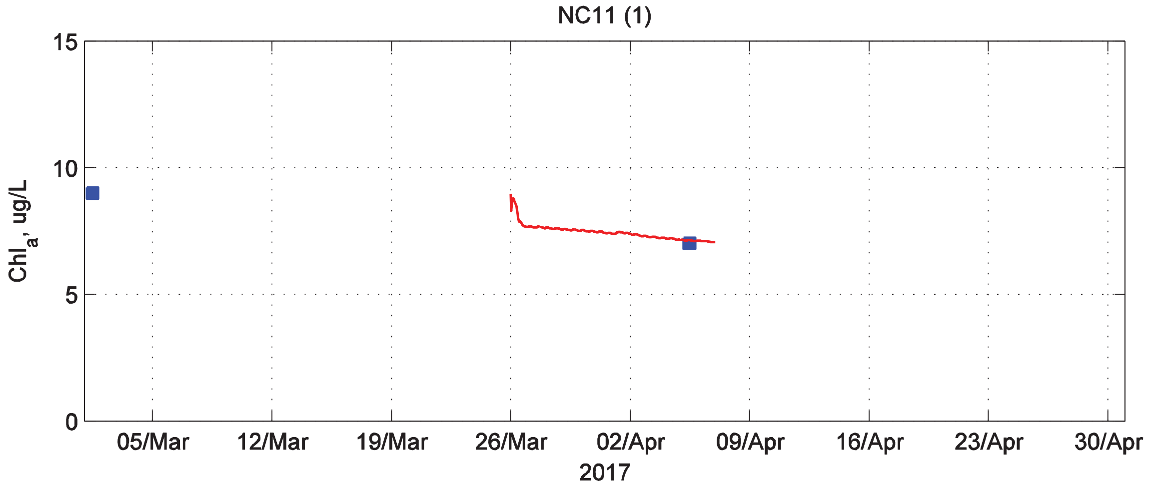

Measured
Calculated
c82 - multi
KM: Surface
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM: Bottom
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
KM: Bottom-Surface
Water Temperature, degC
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

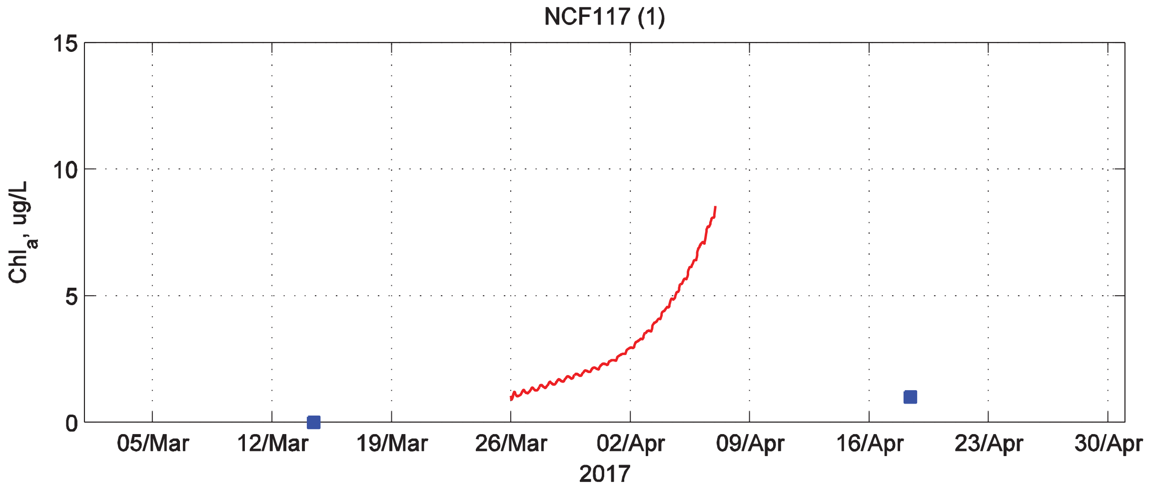

c82 - multi
UBI: Surface
Measured
Calculated
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI: Bottom
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
UBI: Bottom-Surface
Water Temperature, degC
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

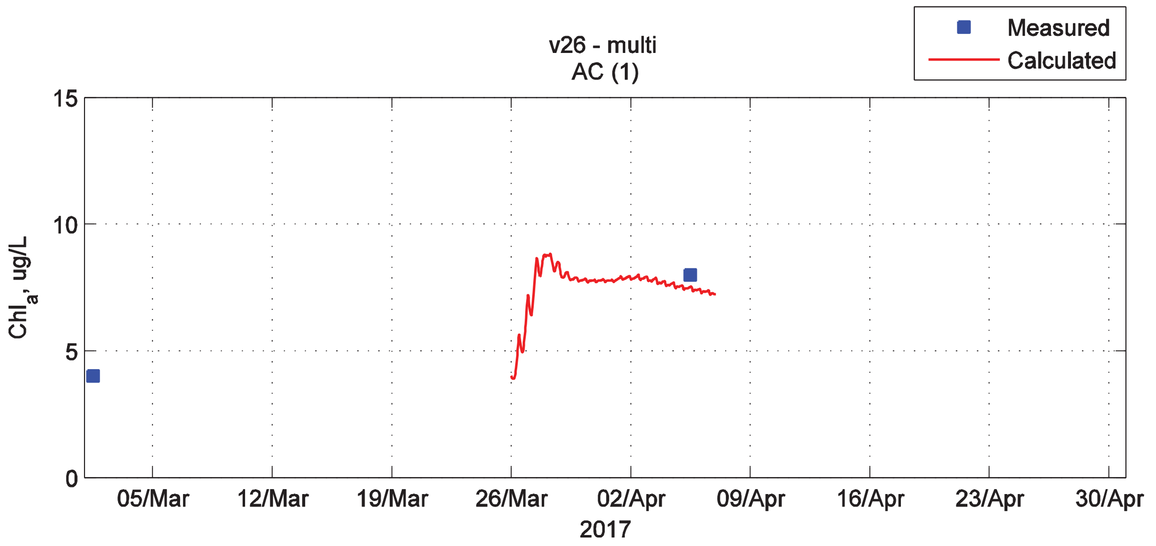

c82 - multi
ADM: Surface
Measured
Calculated
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
ADM: Bottom
Water Temperature, degC
35
30
25
20
15
10
5
0
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017
ADM: Bottom-Surface
Water Temperature, degC
2
1
0
-1
-2
13/Aug
20/Aug
27/Aug
03/Sep
10/Sep
2017

Appendix C–2:
Plots of Modeled & Measured Water Quality Constituents for Spring Validation

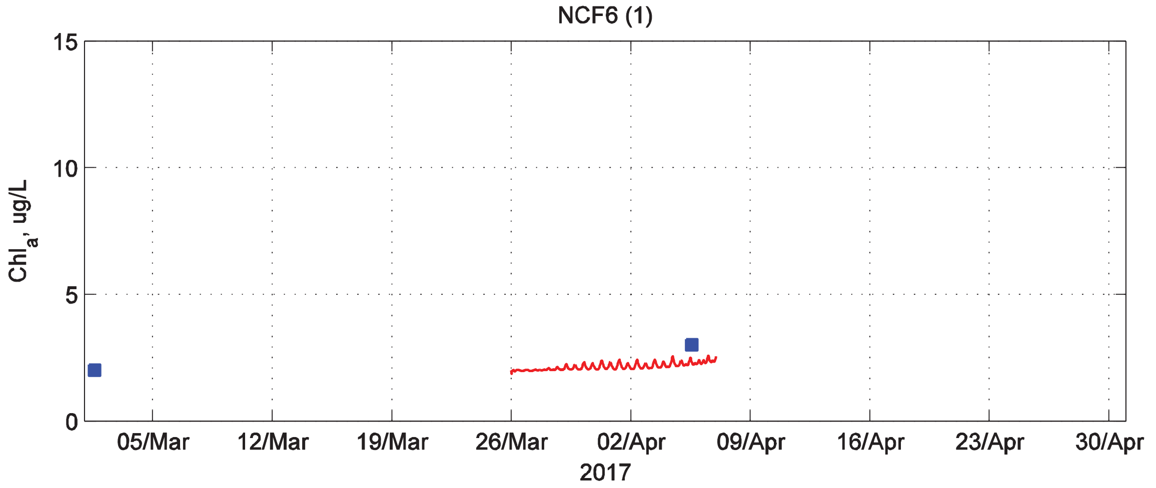

v26 - multi
B210 (1)
■ Measured
Calculated
Chl$_a$, ug/L
15
10
5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017


NC11 (1)
Chl$_a$, ug/L
15
10
5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

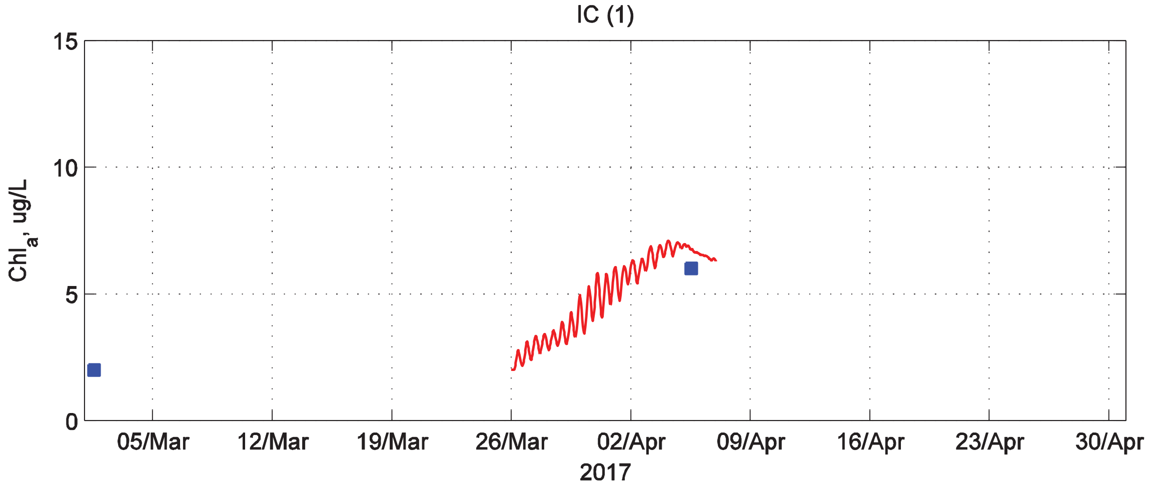

NCF117 (1)
Chl$_a$, ug/L
15
10
5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017



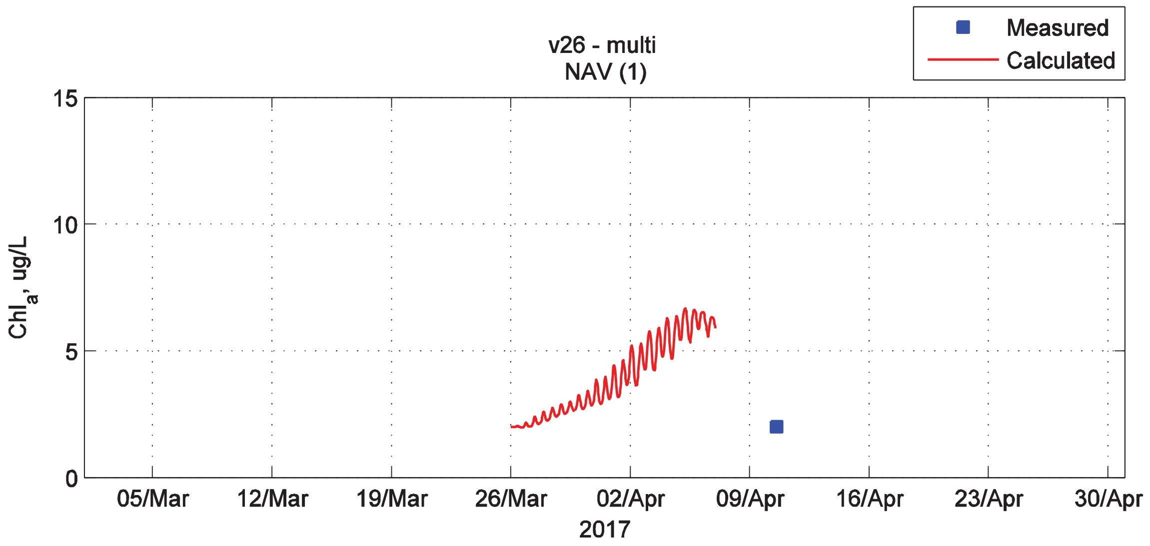
v26 - multi
AC (1)

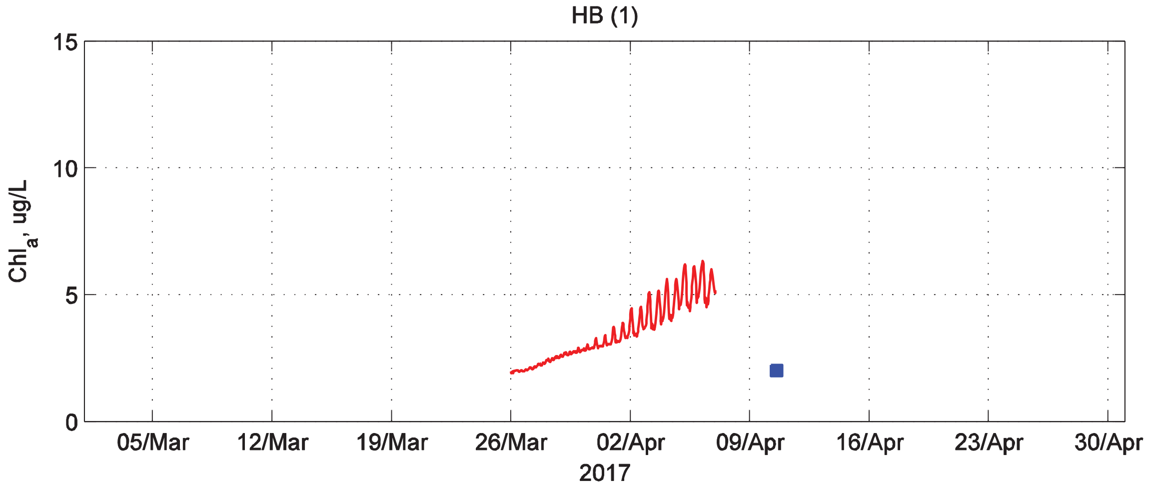


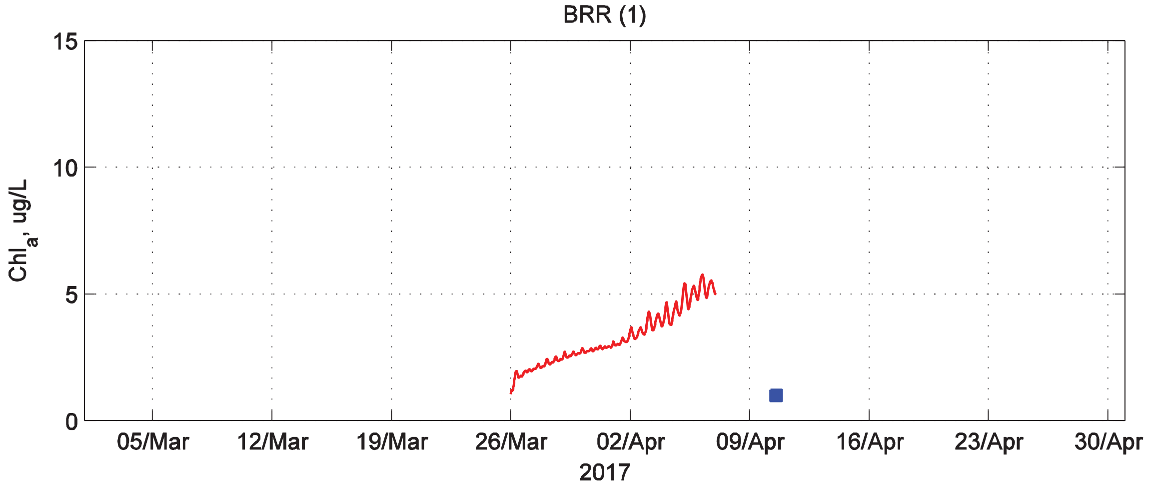
NCF6 (1)



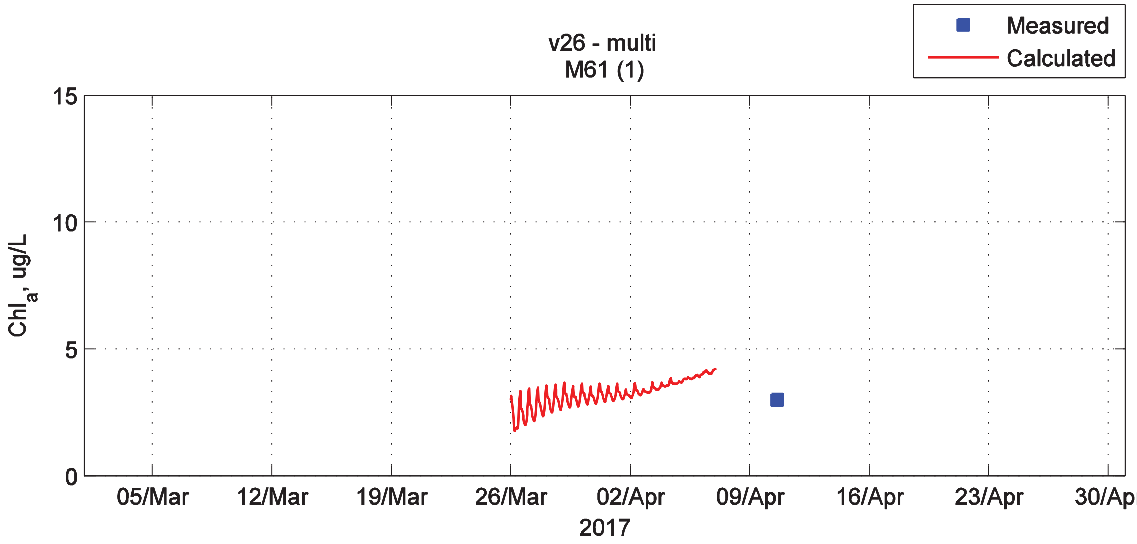
IC (1)


v26 - multi
NAV (1)

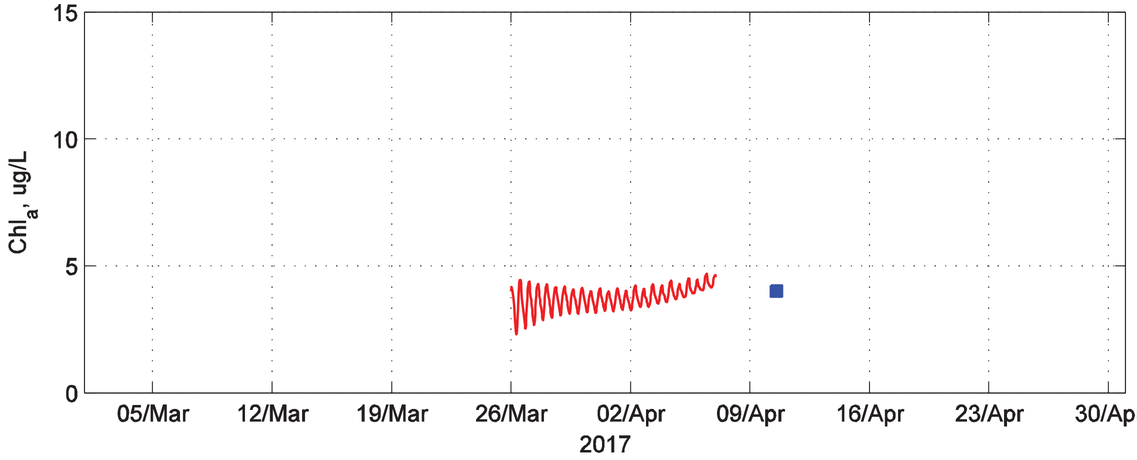

HB (1)


BRR (1)

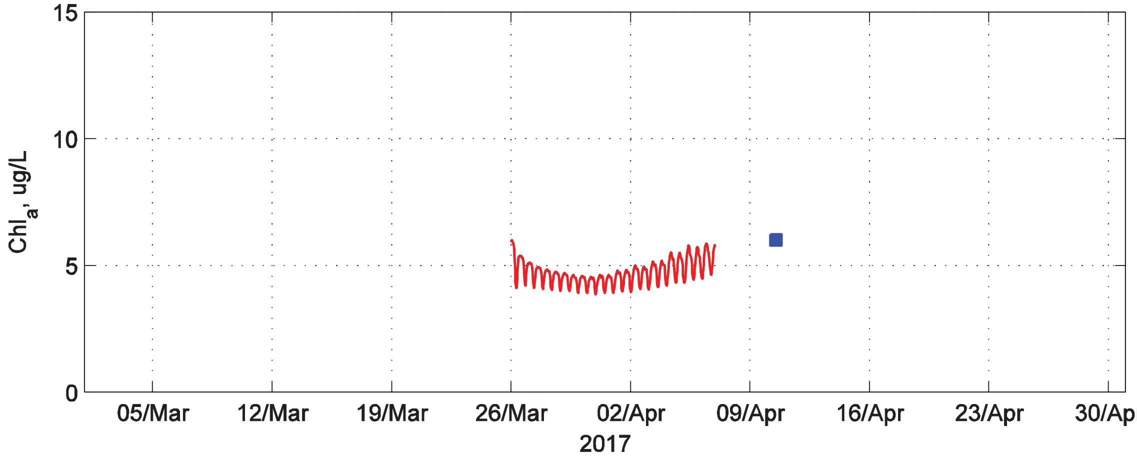
v26 - multi
M61 (1)

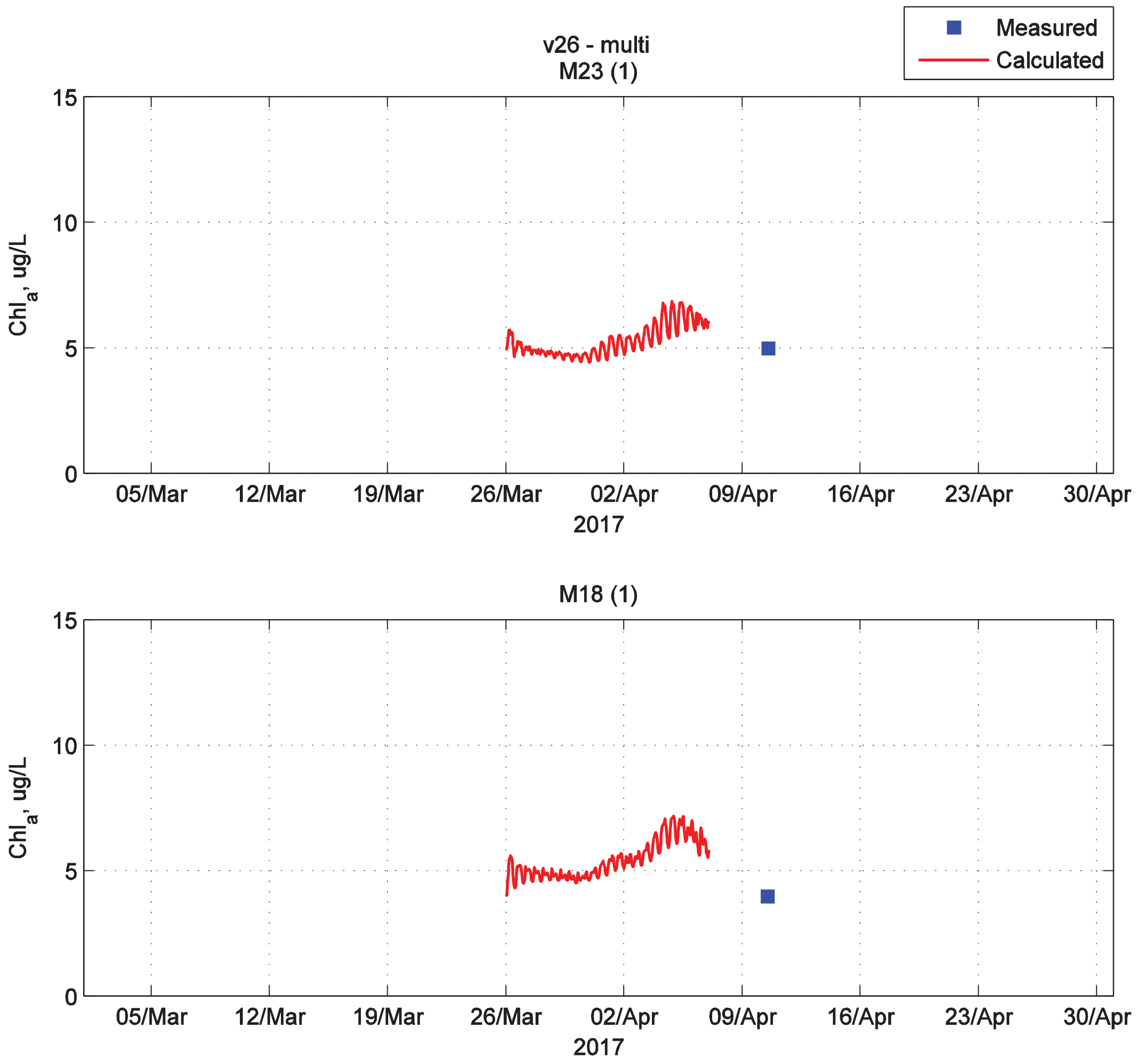


M54 (1)



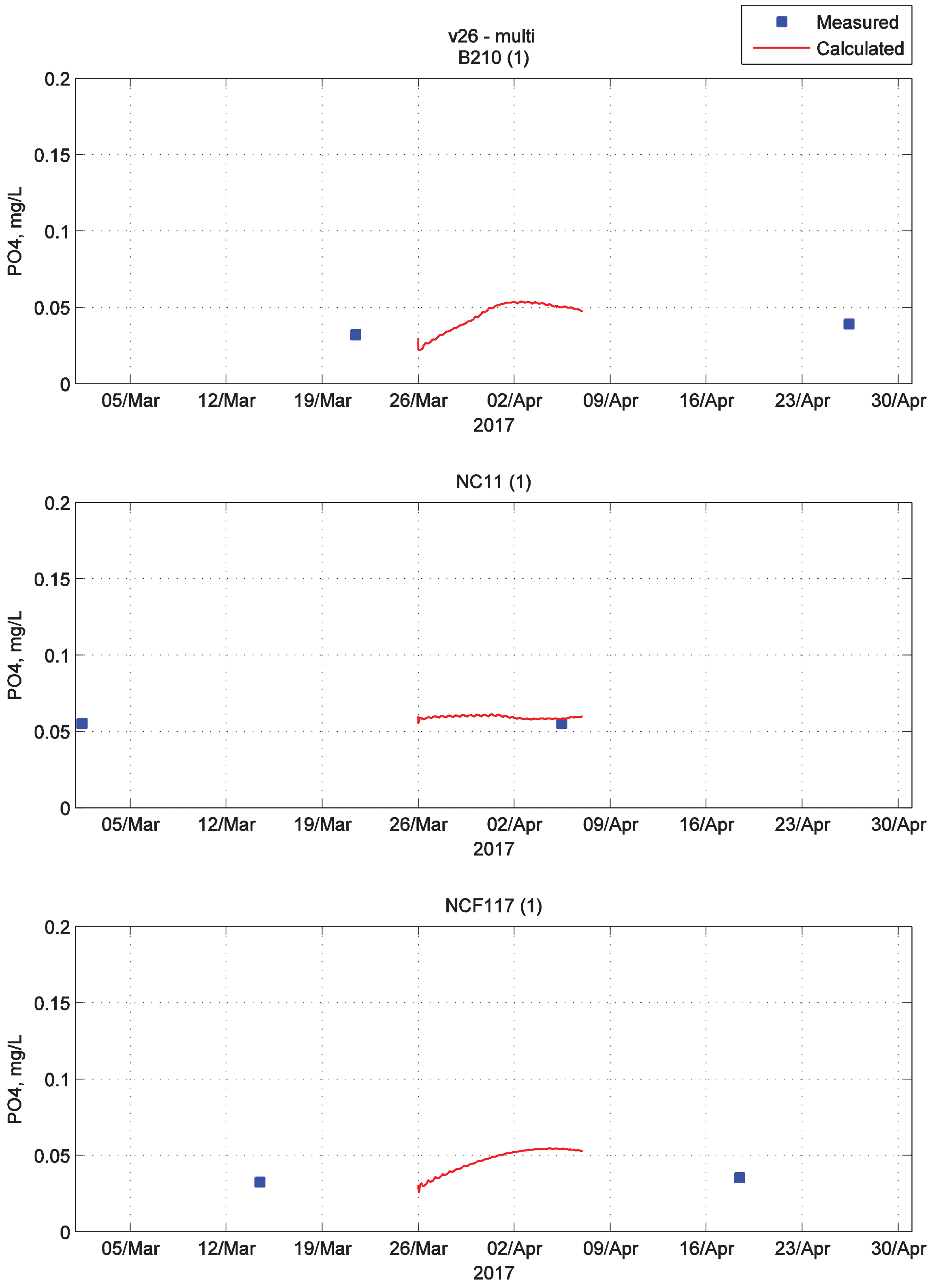
M35 (1)

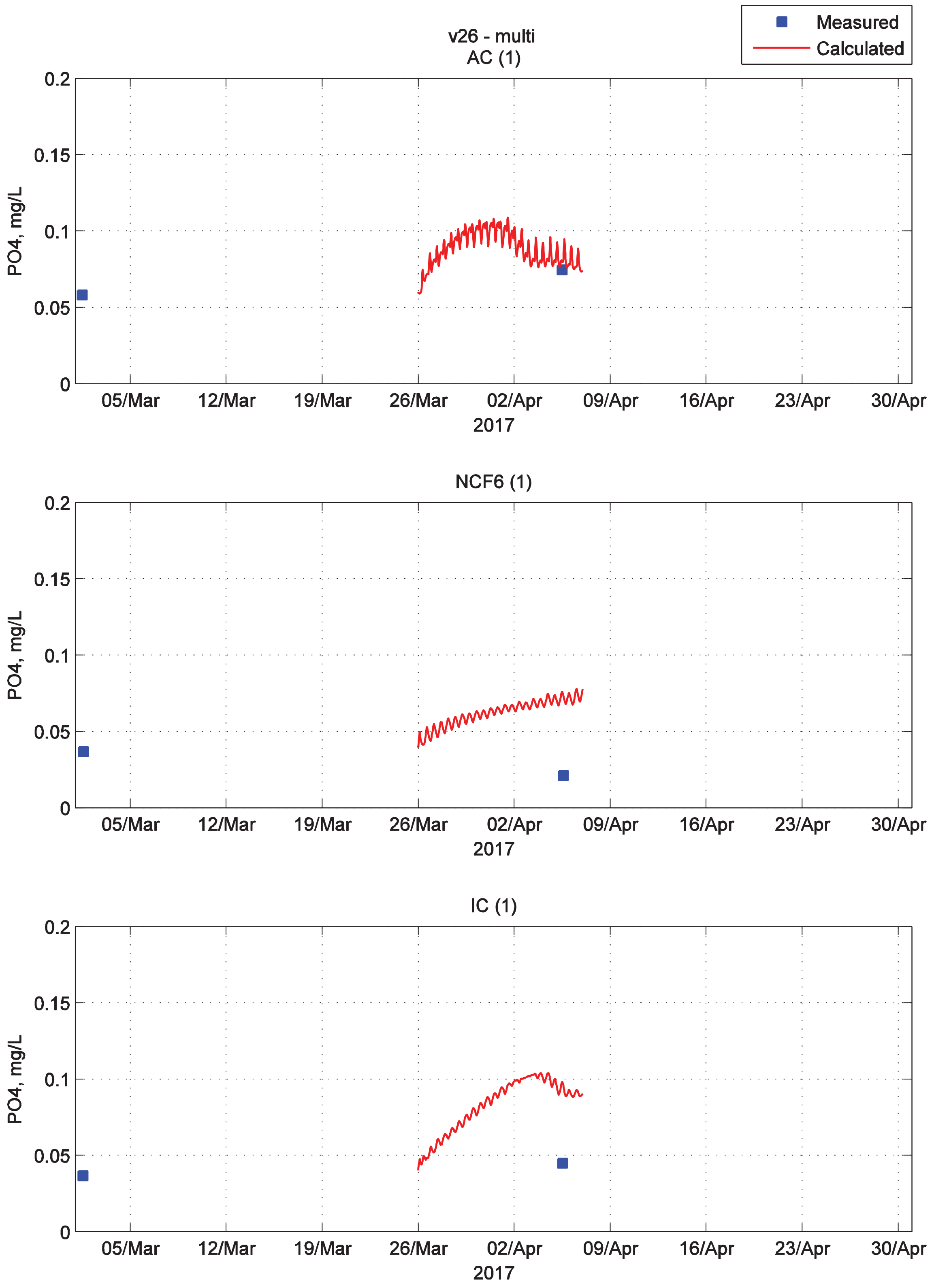


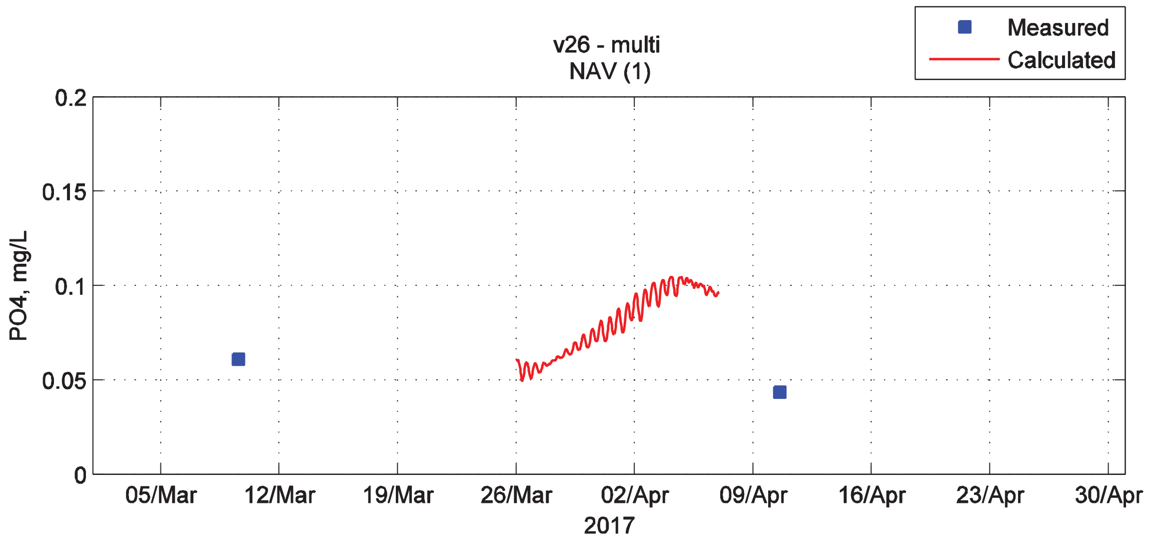

v26 - multi

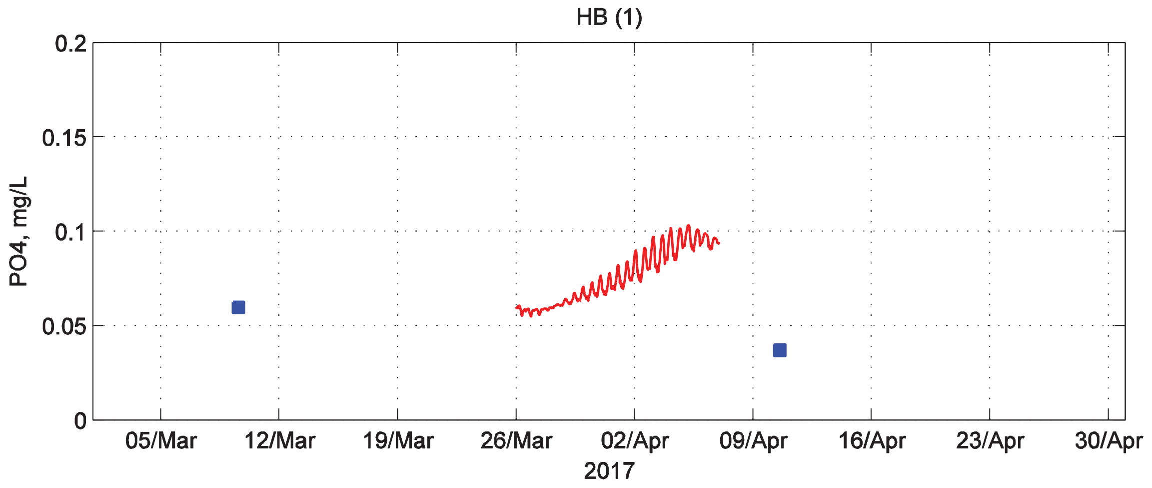
M23 (1)

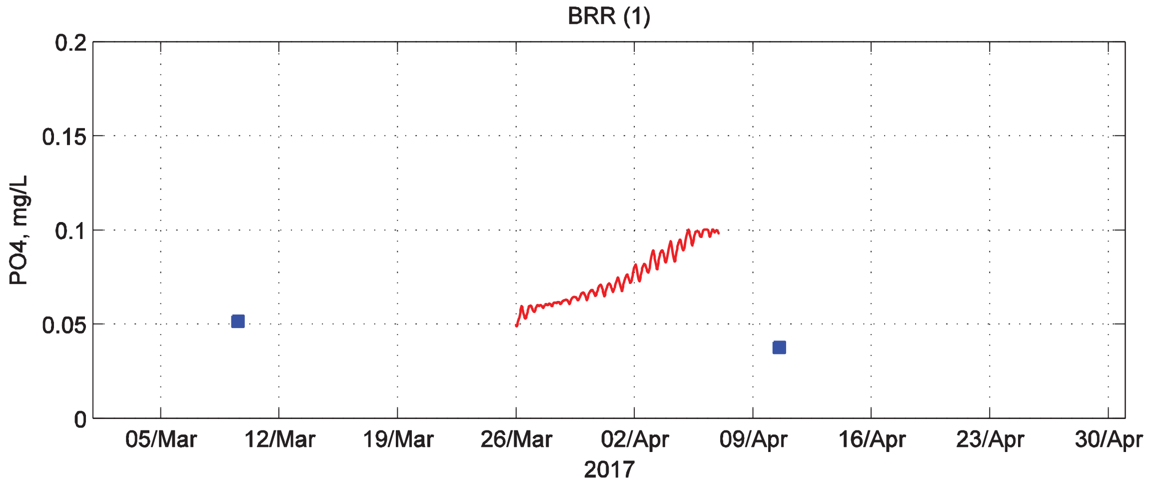
M18 (1)

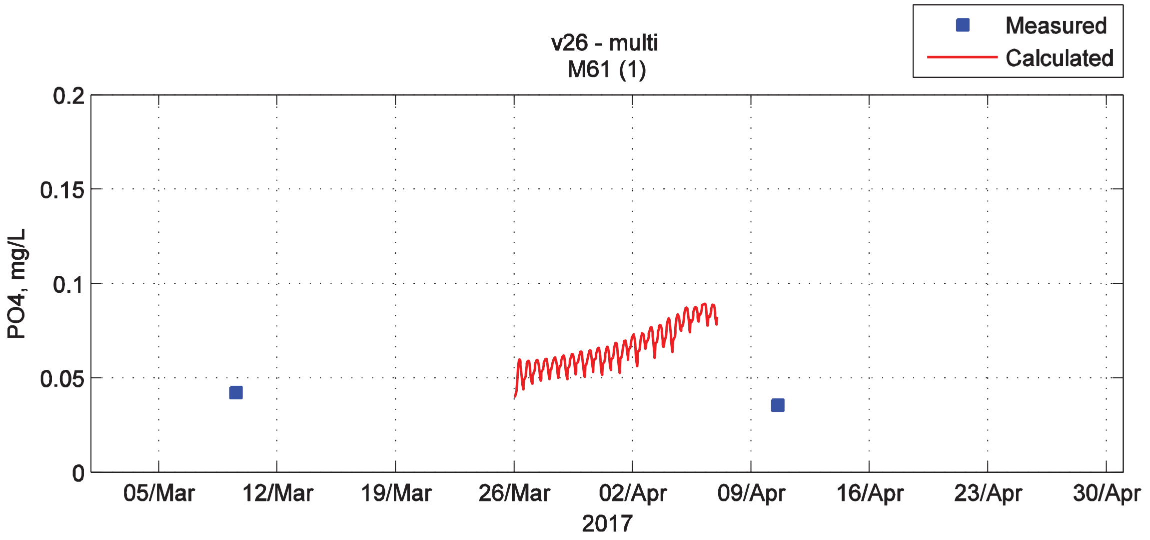

v26 - multi
B210 (1)
■ Measured
Calculated
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NC11 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NCF117 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

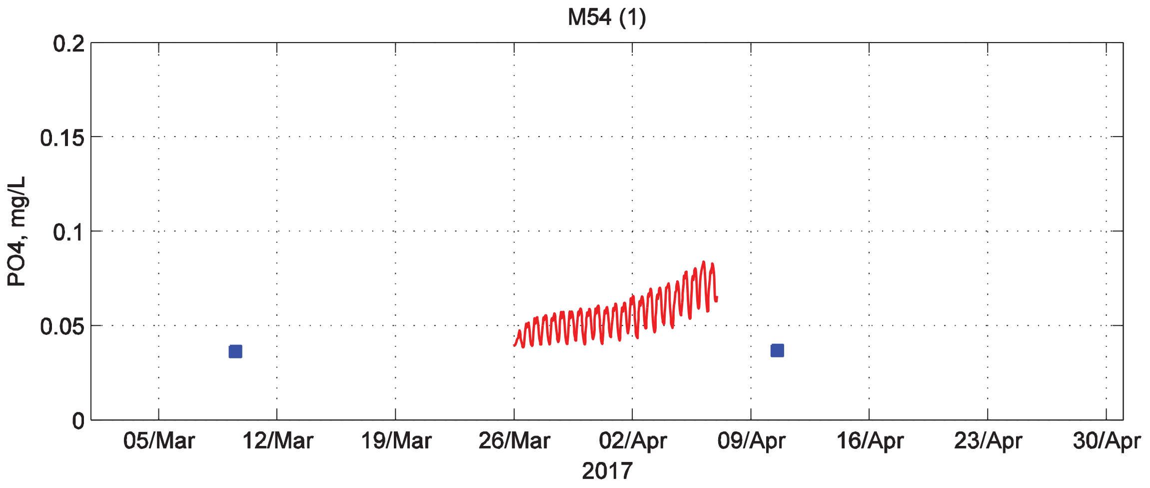

Measured
Calculated
v26 - multi
AC (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NCF6 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
IC (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

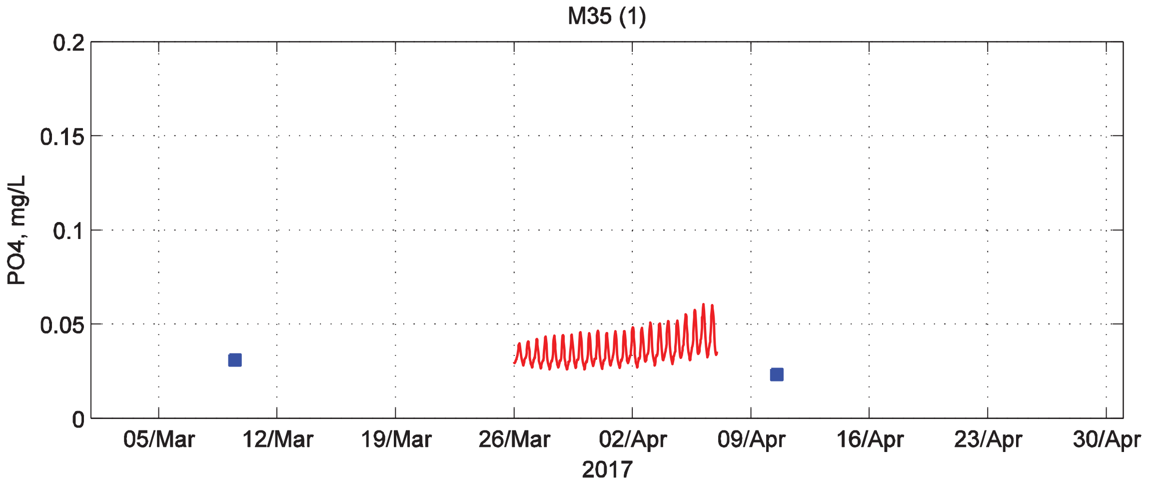

v26 - multi
NAV (1)
Measured
Calculated
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

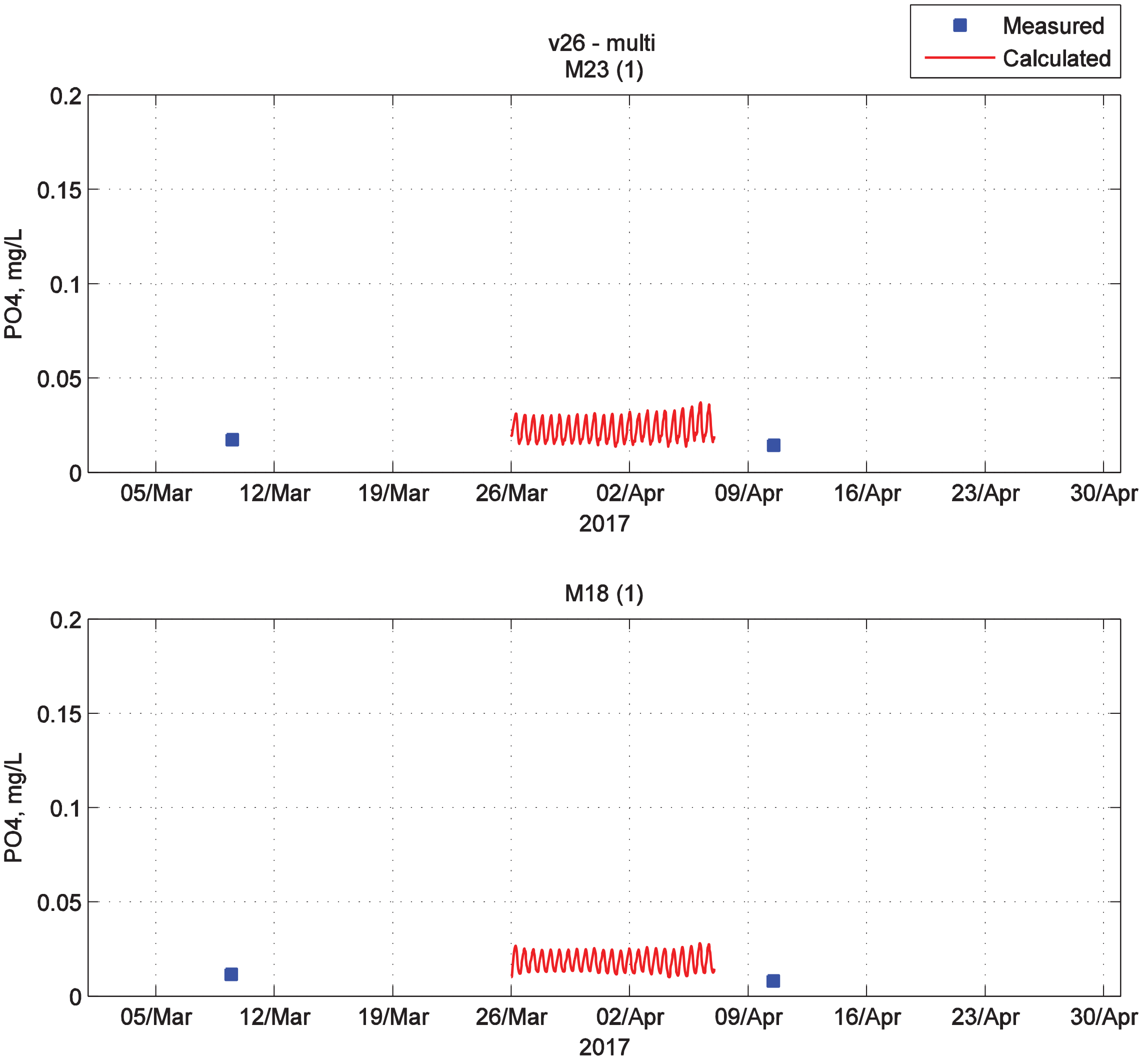

HB (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

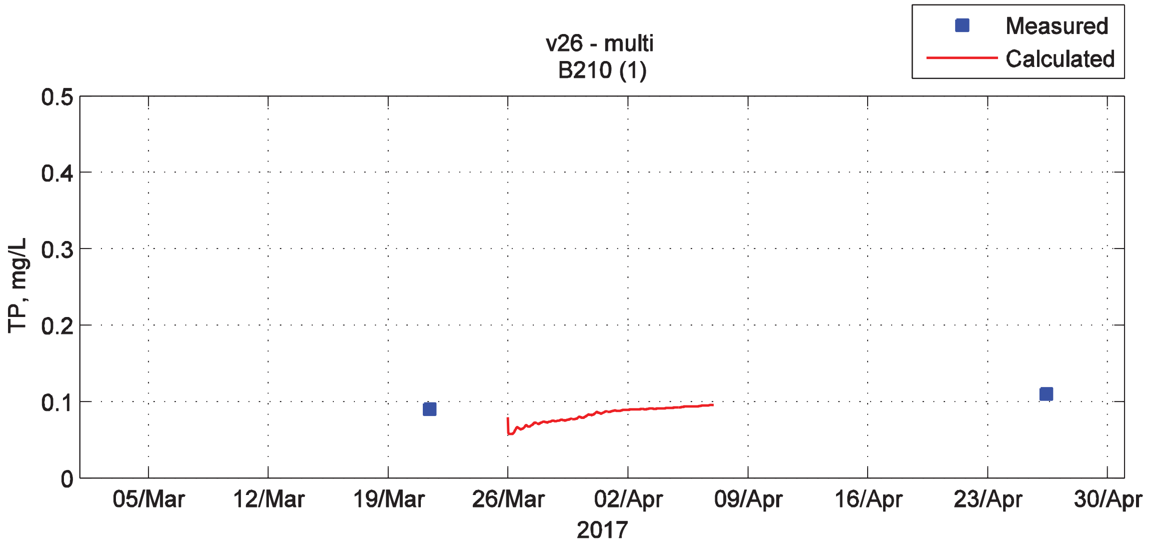

BRR (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

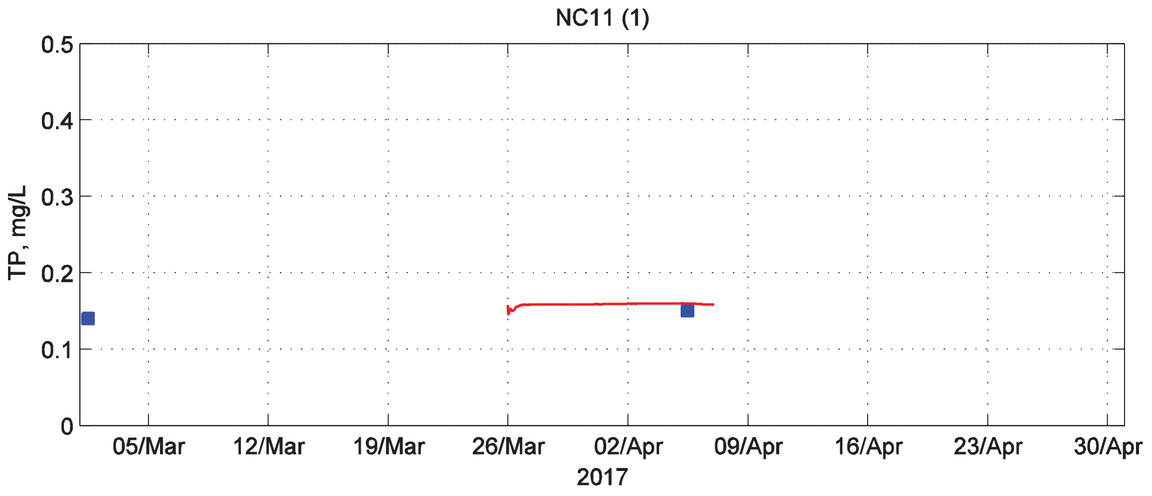

Measured
Calculated
v26 - multi
M61 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

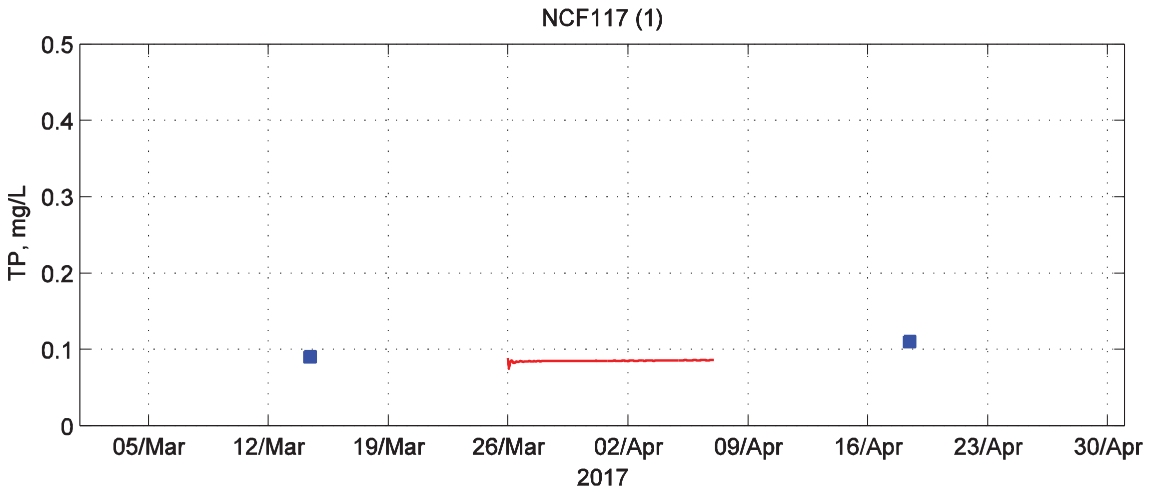

M54 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

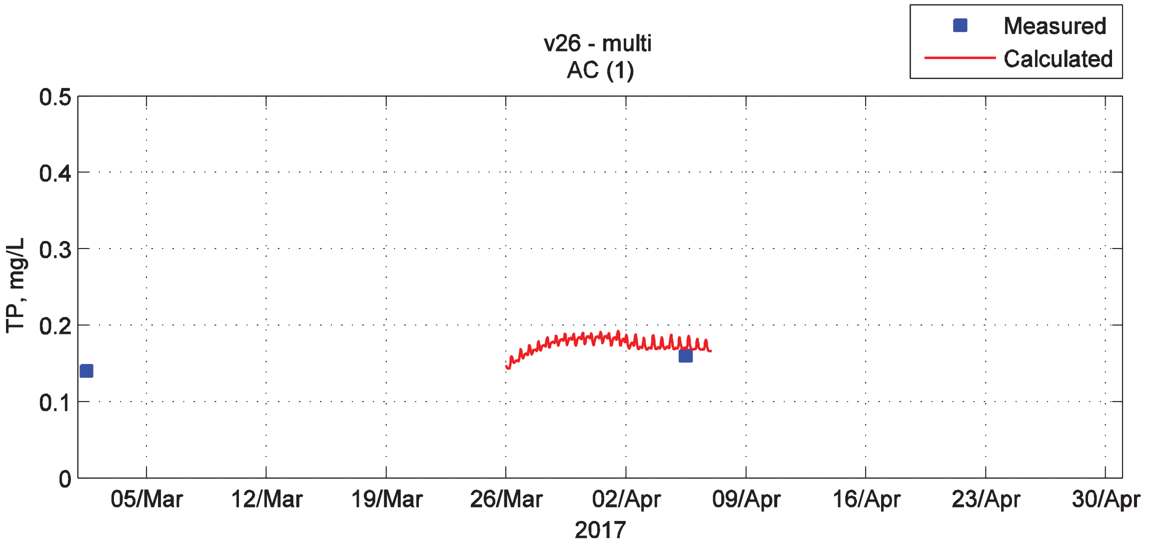

M35 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

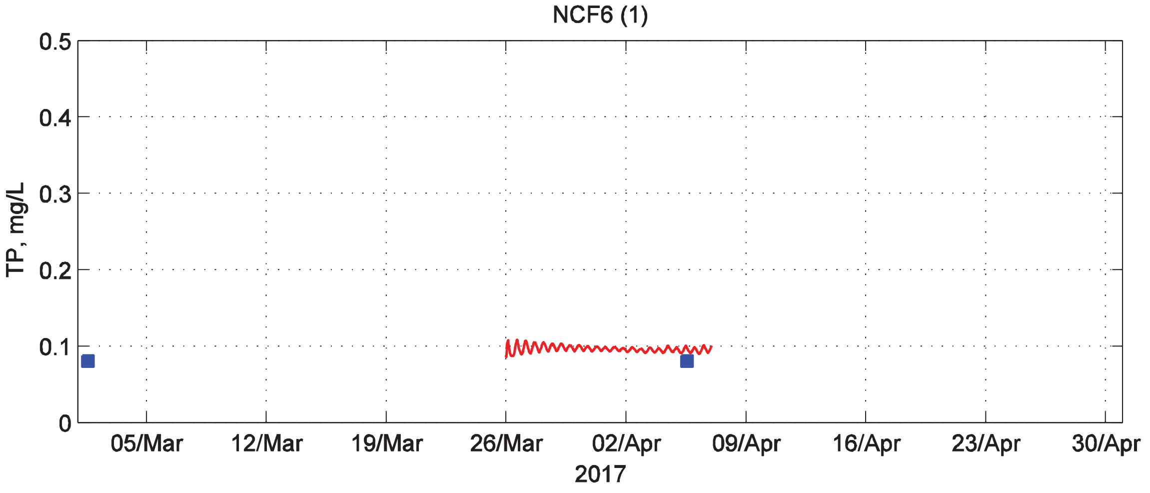

Measured
Calculated
v26 - multi
M23 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M18 (1)
PO4, mg/L
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

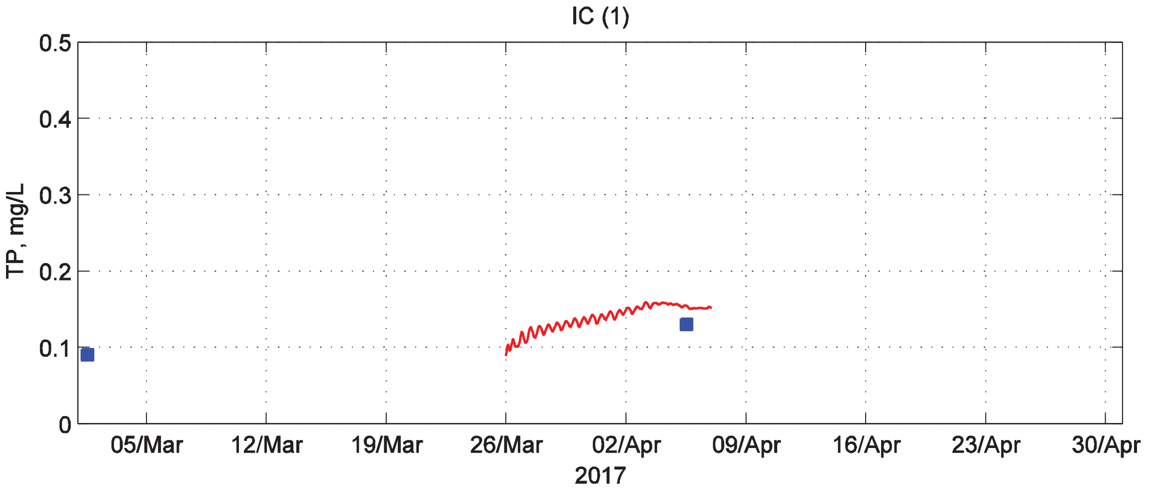

v26 - multi
B210 (1)
■ Measured
Calculated
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

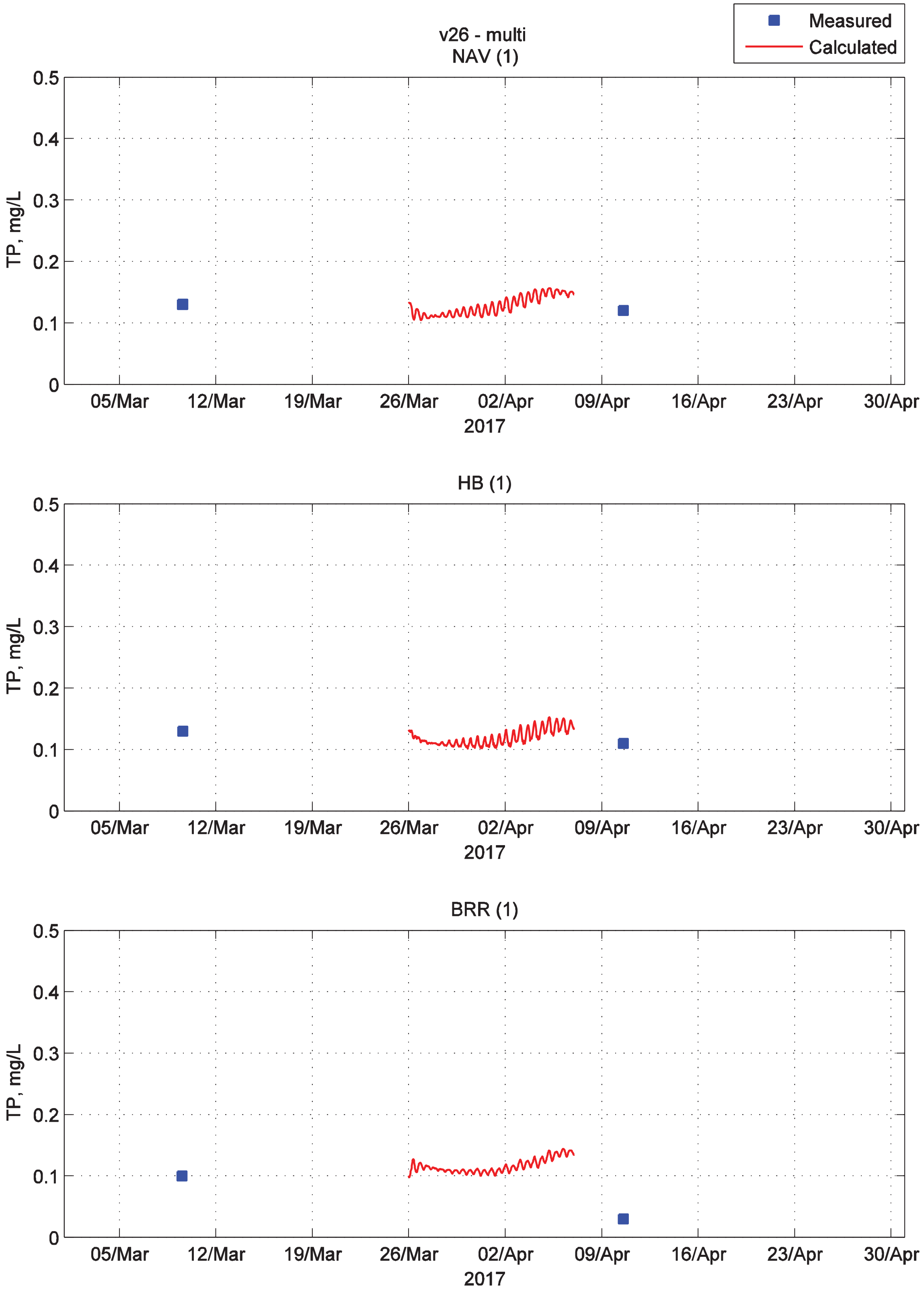

NC11 (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

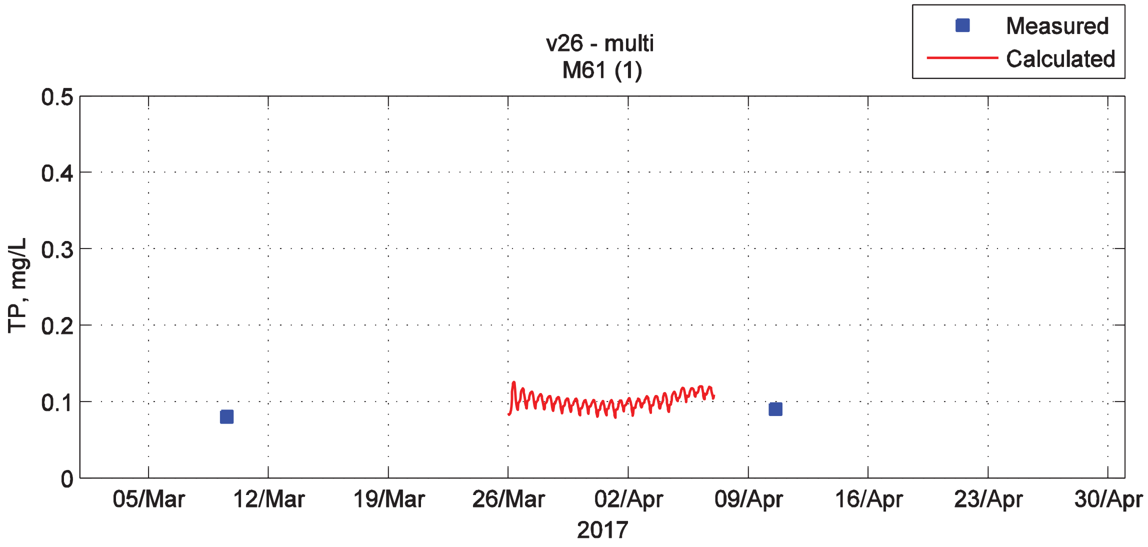

NCF117 (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

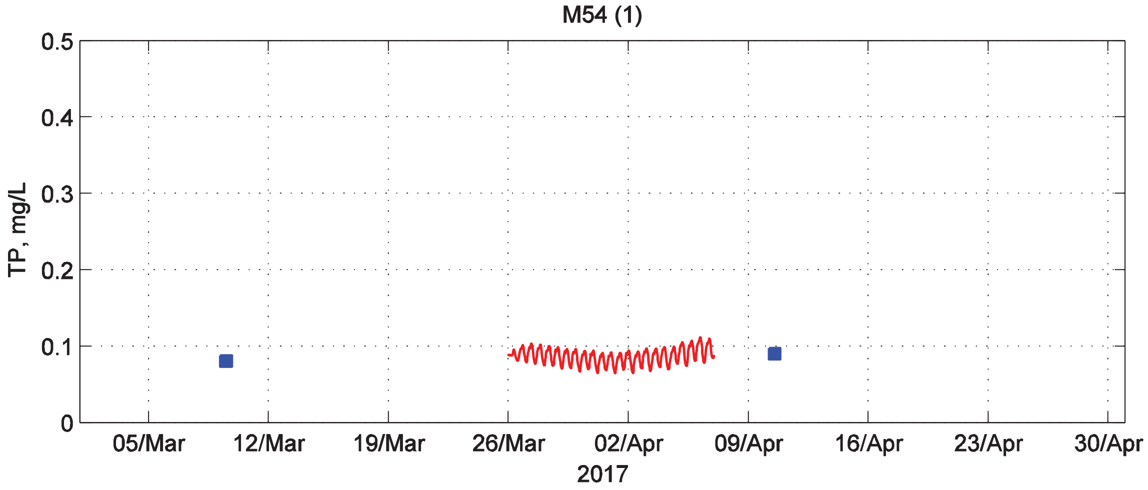

Measured
Calculated
v26 - multi
AC (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

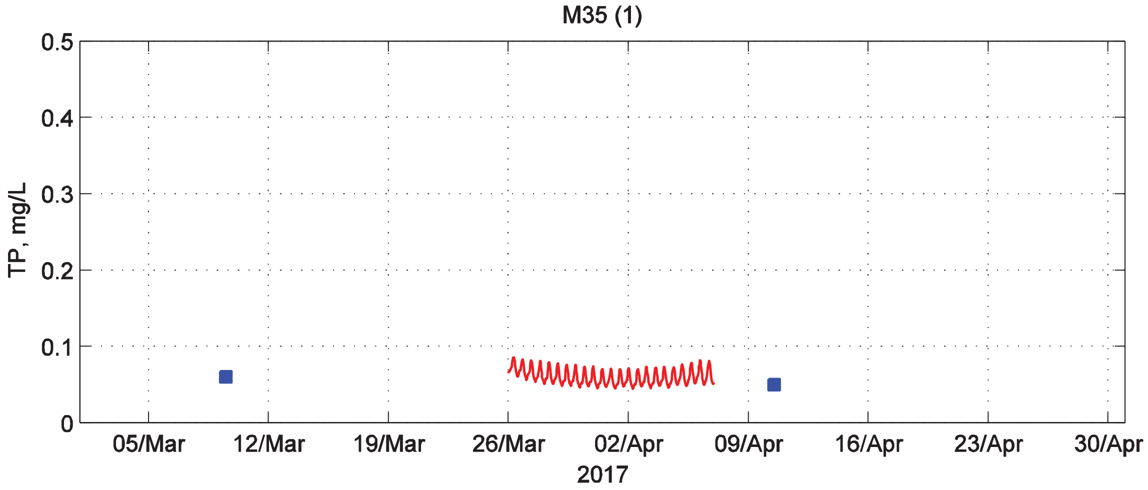

NCF6 (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

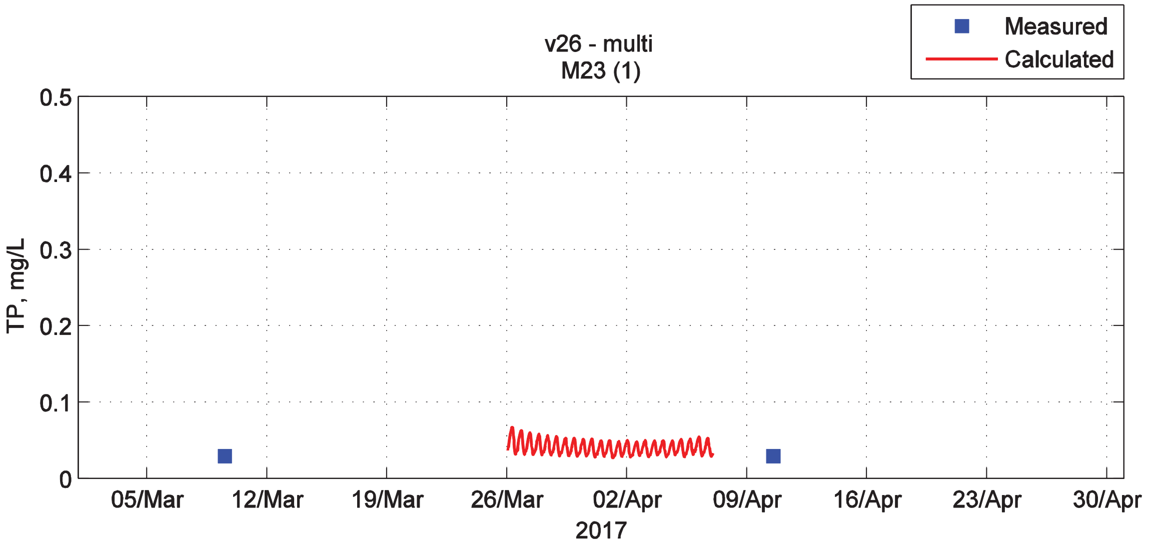

IC (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

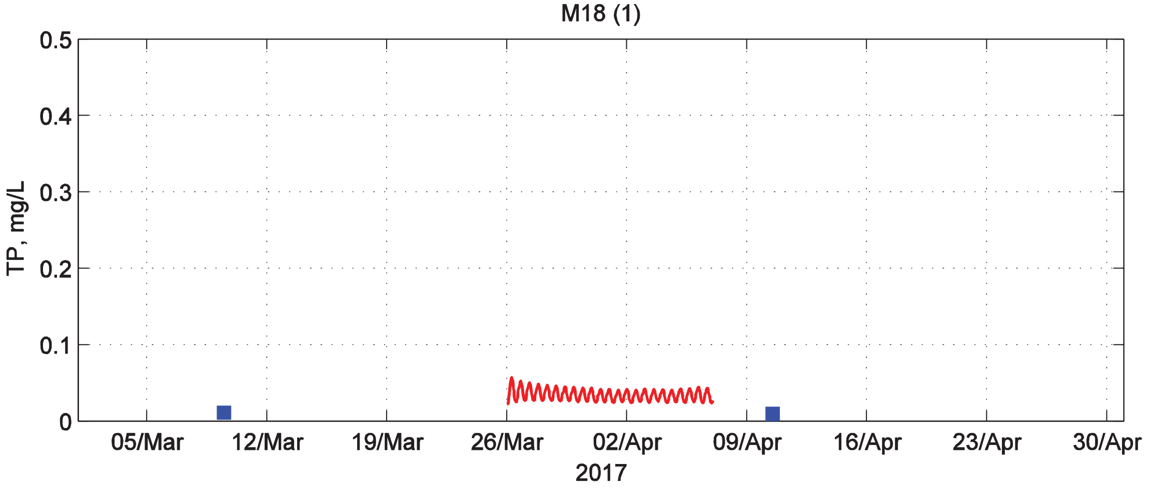

■ Measured
— Calculated
v26 - multi
NAV (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
HB (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
BRR (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

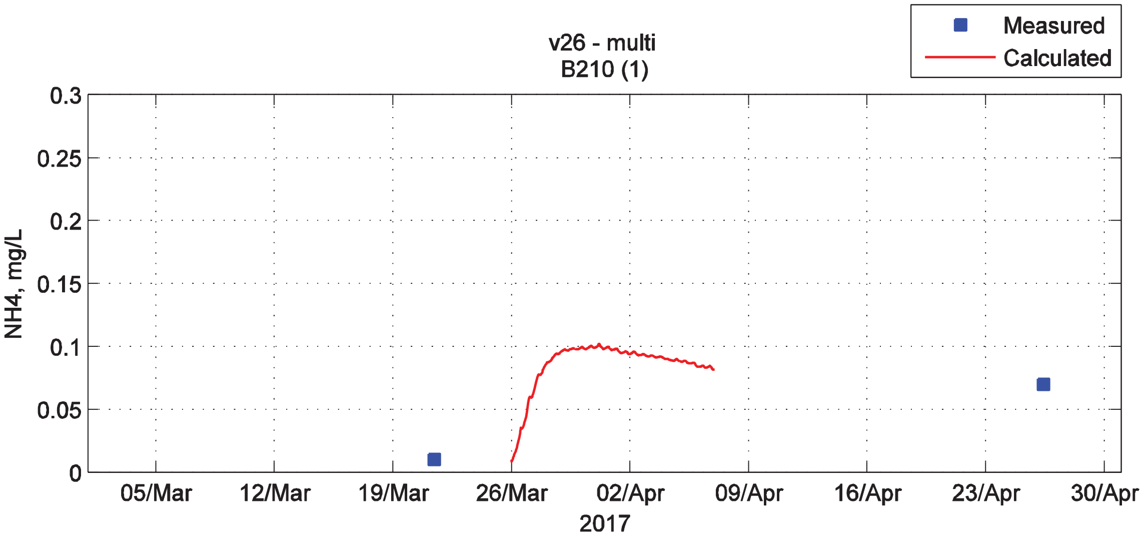

v26 - multi
M61 (1)

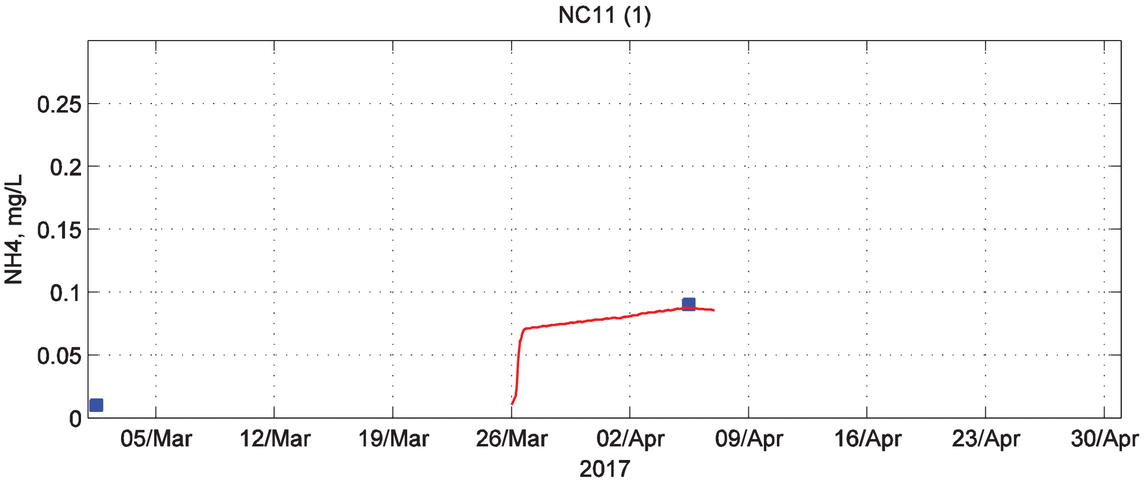

M54 (1)

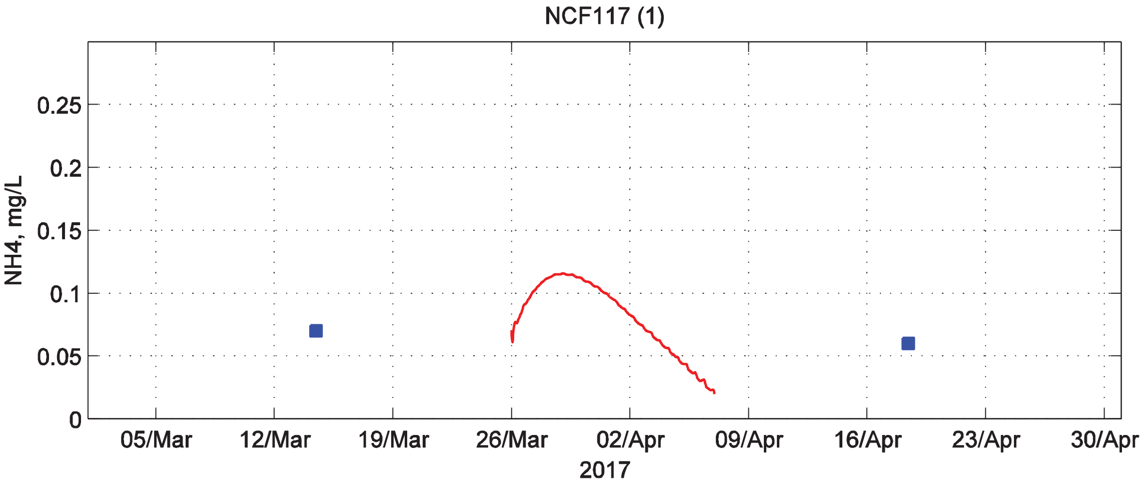

M35 (1)

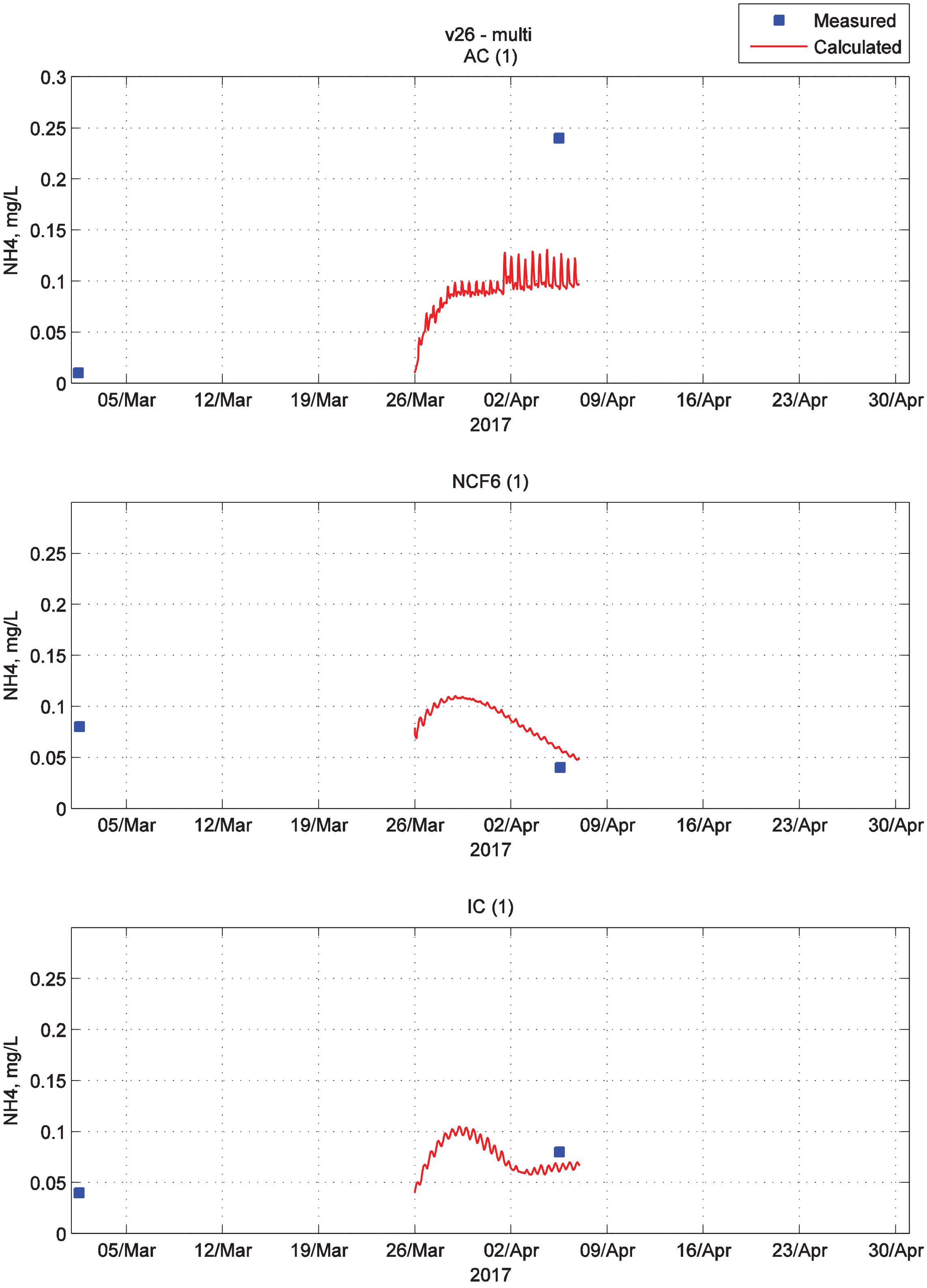

v26 - multi
M23 (1)
Measured
Calculated
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

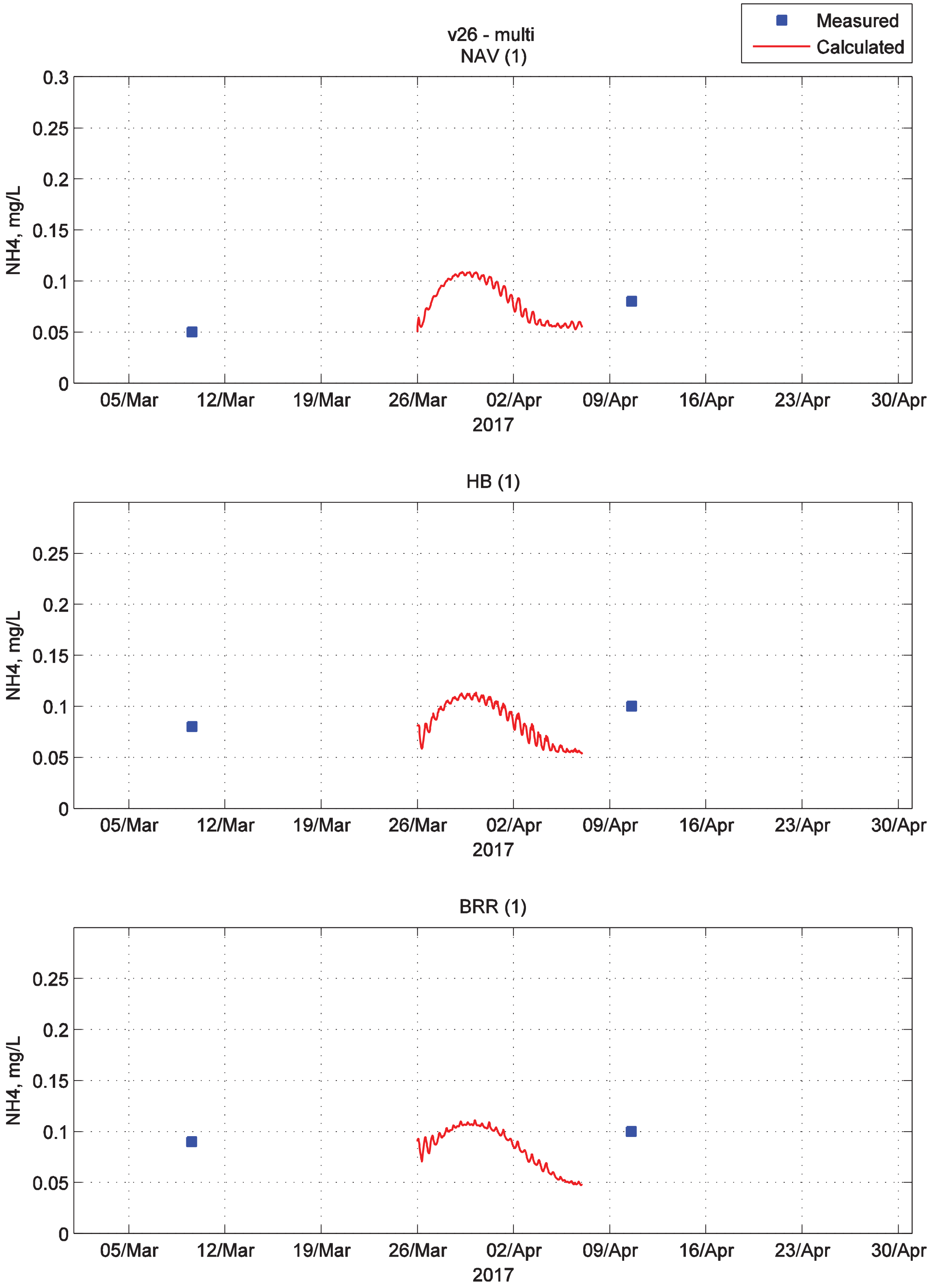

M18 (1)
TP, mg/L
0.5
0.4
0.3
0.2
0.1
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

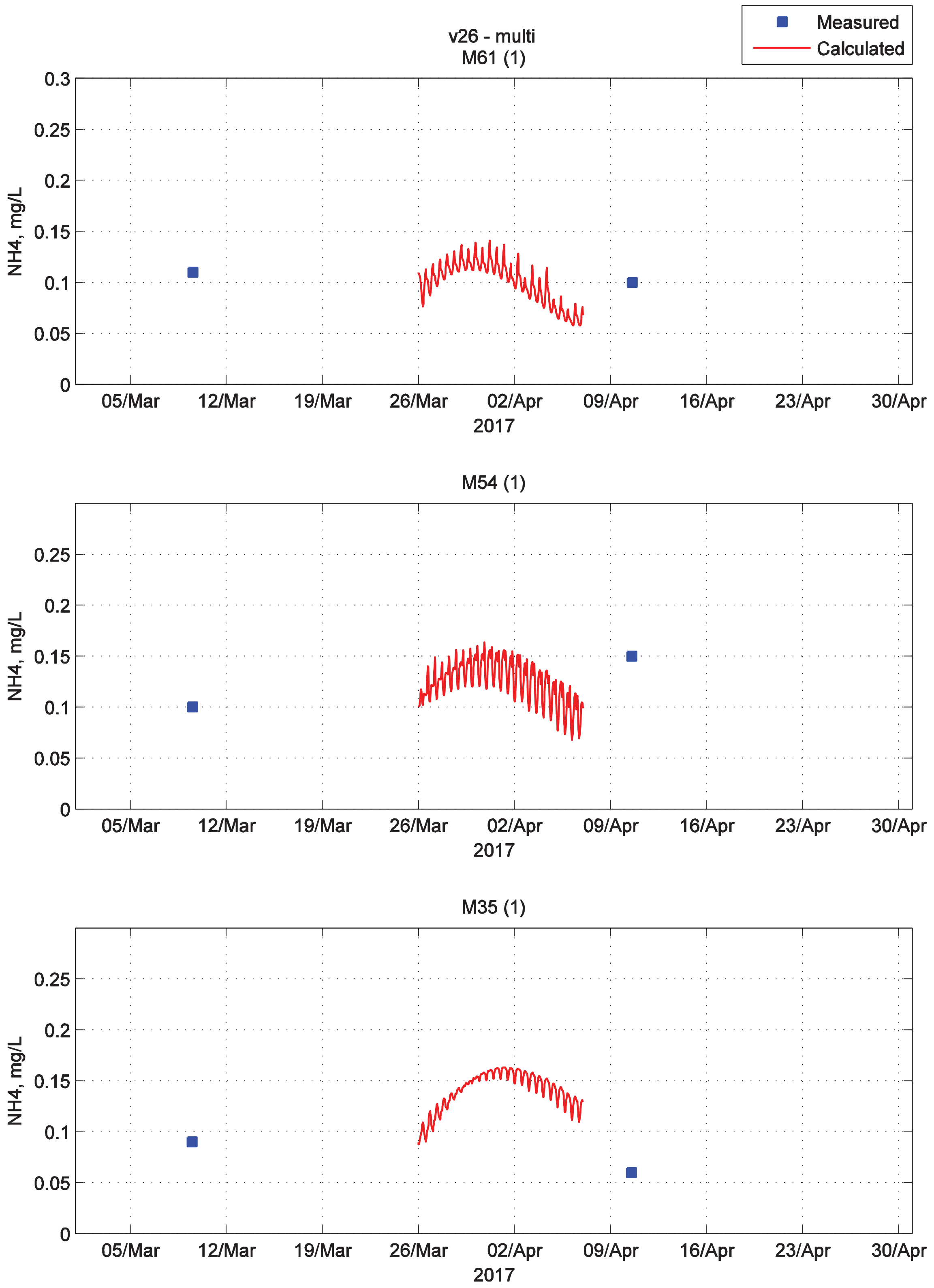

v26 - multi
B210 (1)

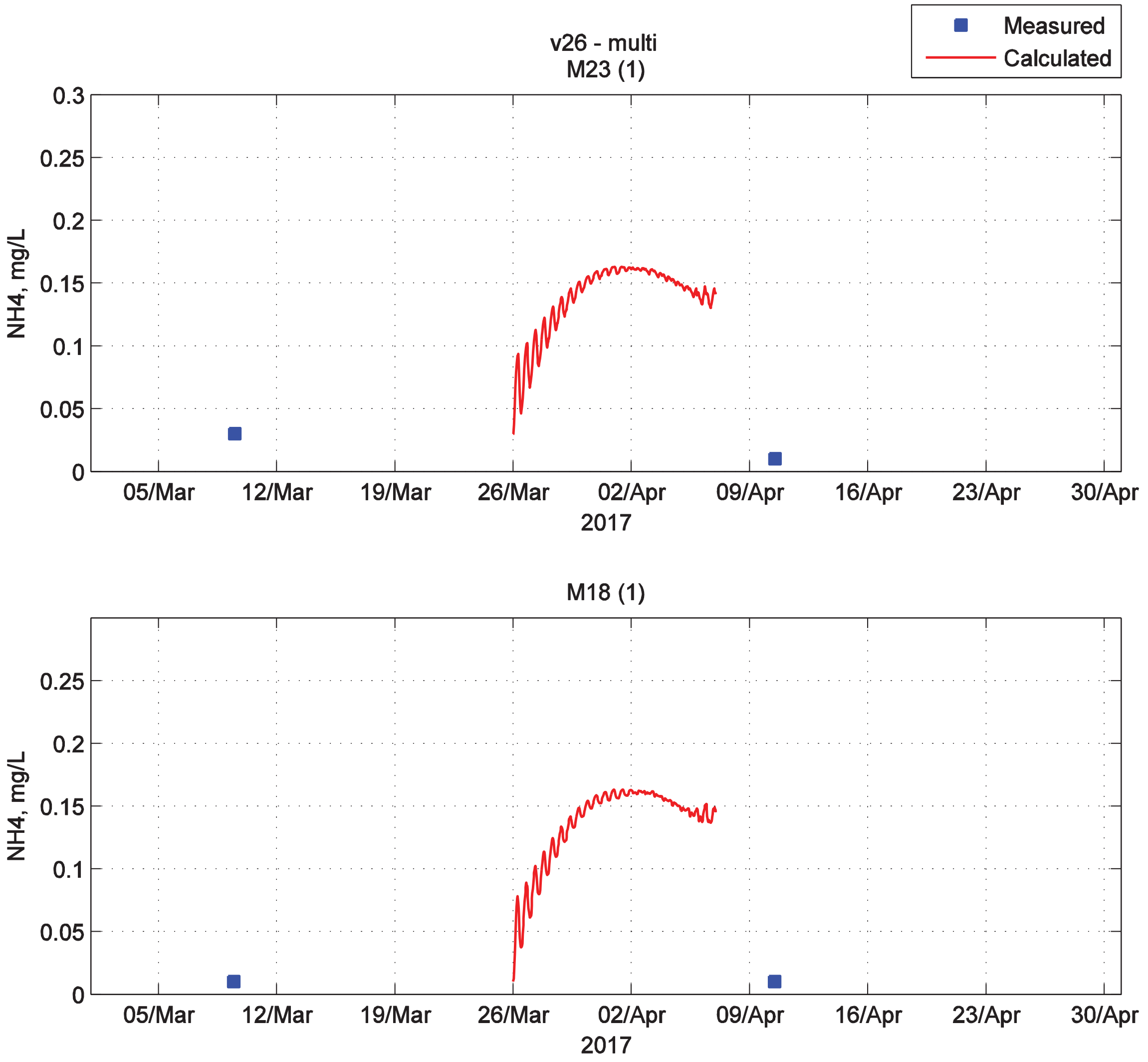

NC11 (1)

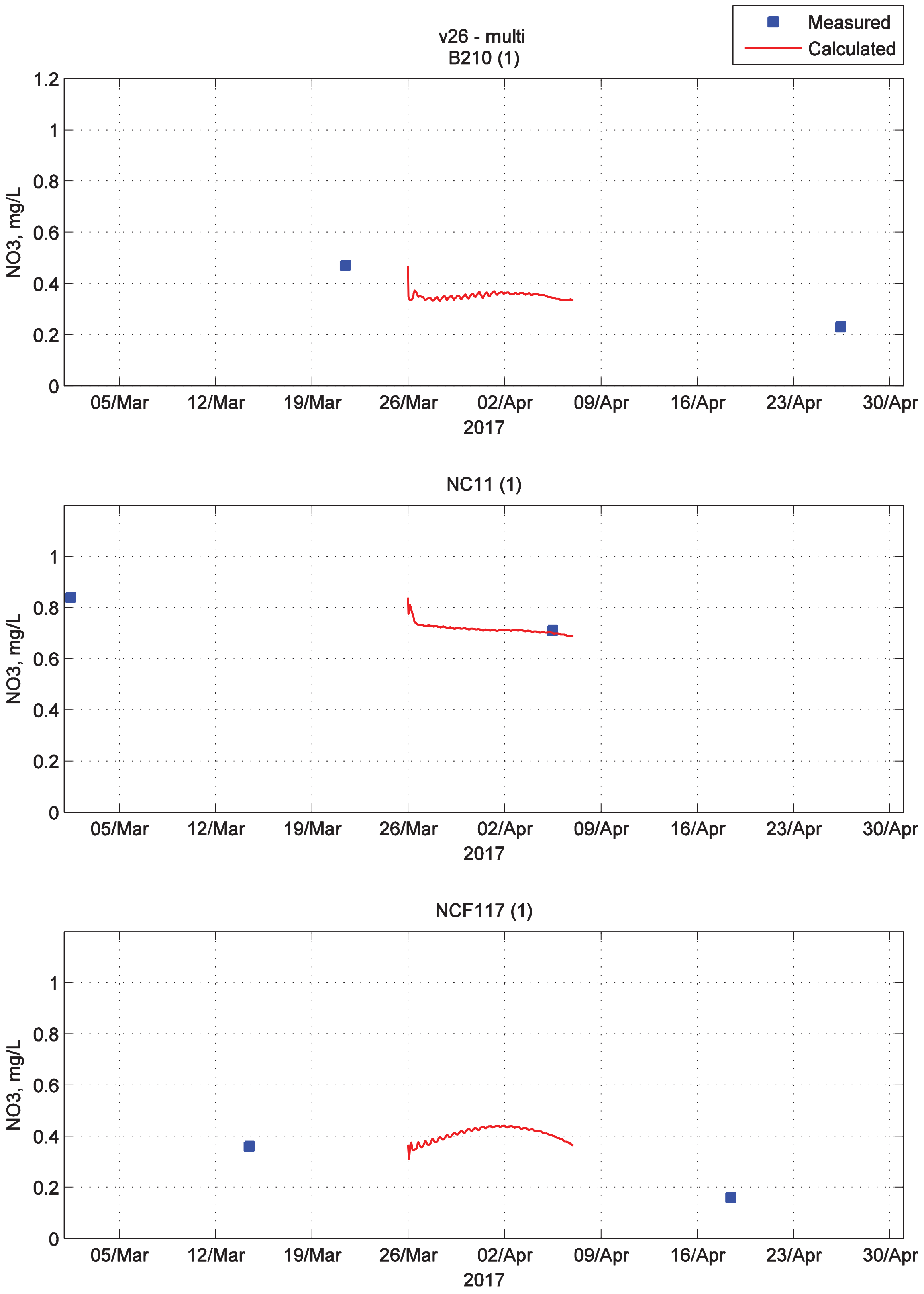

NCF117 (1)

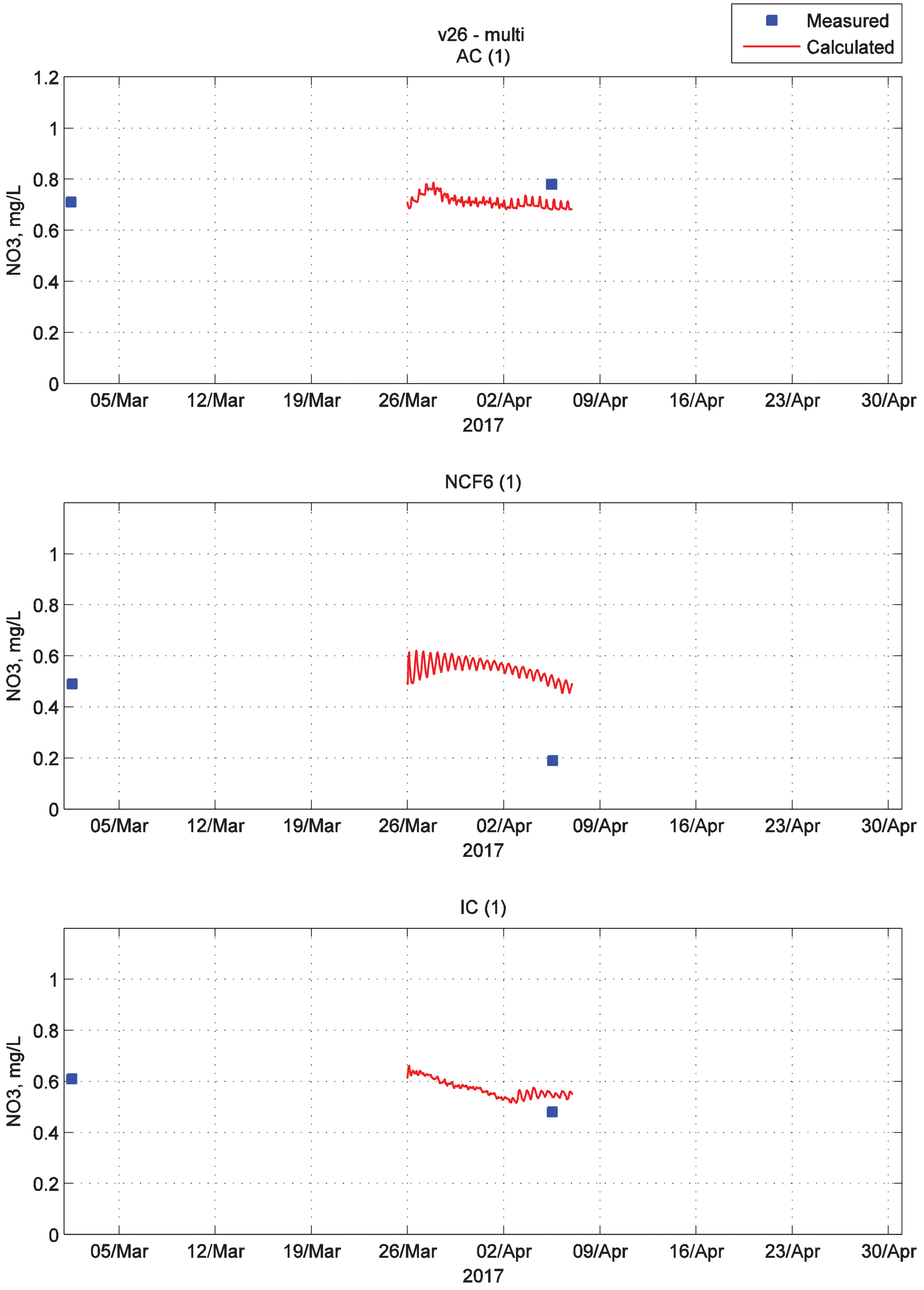

Measured
Calculated
v26 - multi
AC (1)
NH4, mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NCF6 (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
IC (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

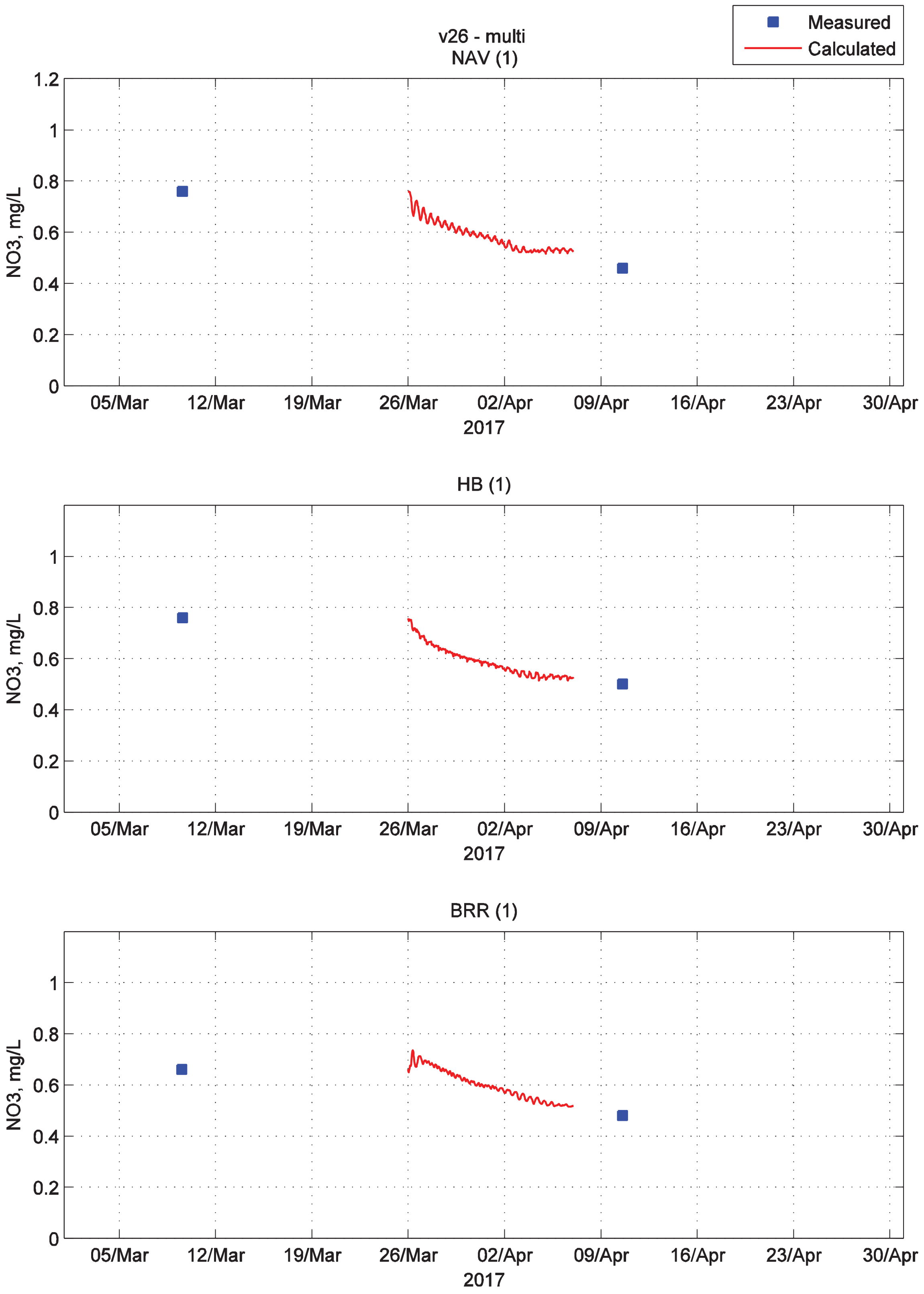

Measured
Calculated
v26 - multi
NAV (1)
NH4, mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
HB (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
BRR (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

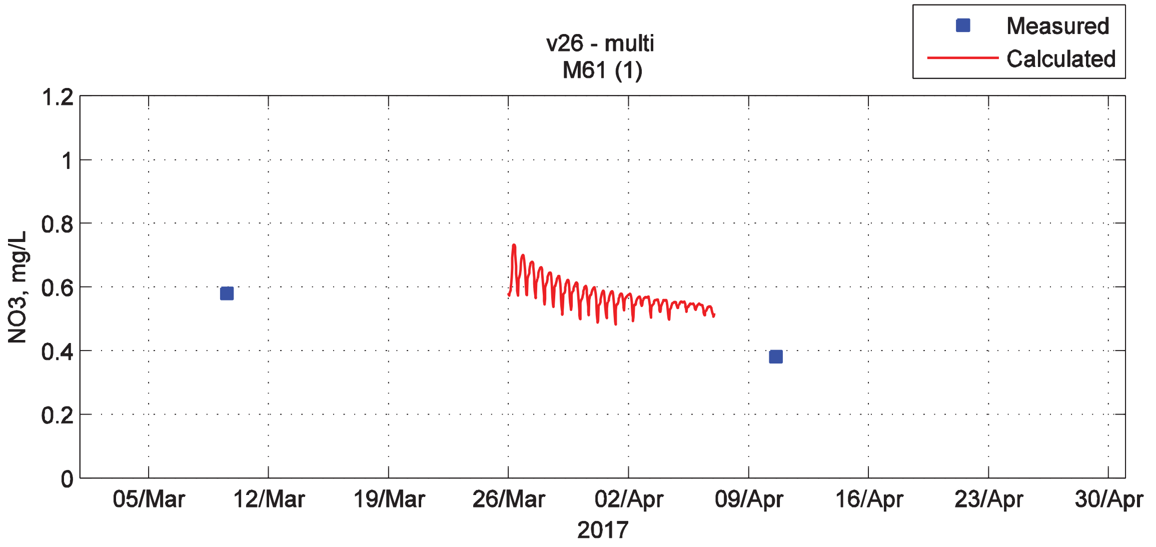

v26 - multi
Measured
Calculated
M61 (1)
M54 (1)
M35 (1)
NH4, mg/L
0
0.05
0.1
0.15
0.2
0.25
0.3
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

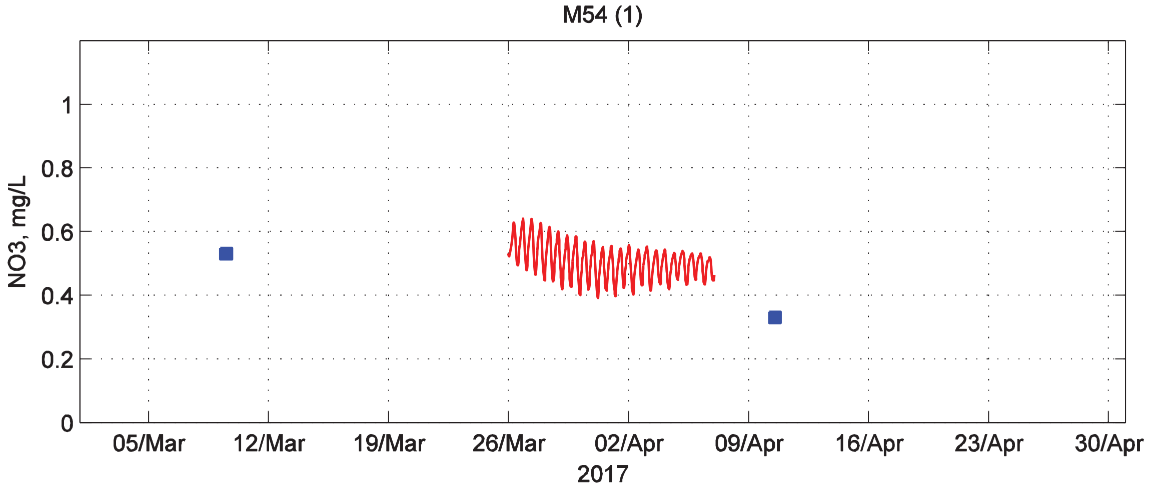

Measured
Calculated
v26 - multi
M23 (1)
NH4, mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M18 (1)
NH4, mg/L
0.25
0.2
0.15
0.1
0.05
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

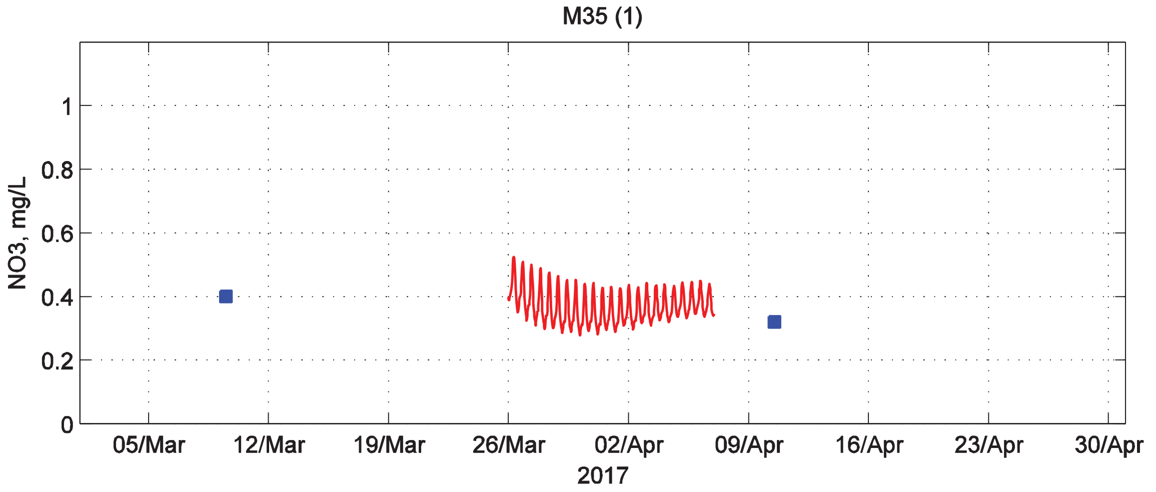

Measured
Calculated
v26 - multi
B210 (1)
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
1.2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NC11 (1)
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NCF117 (1)
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

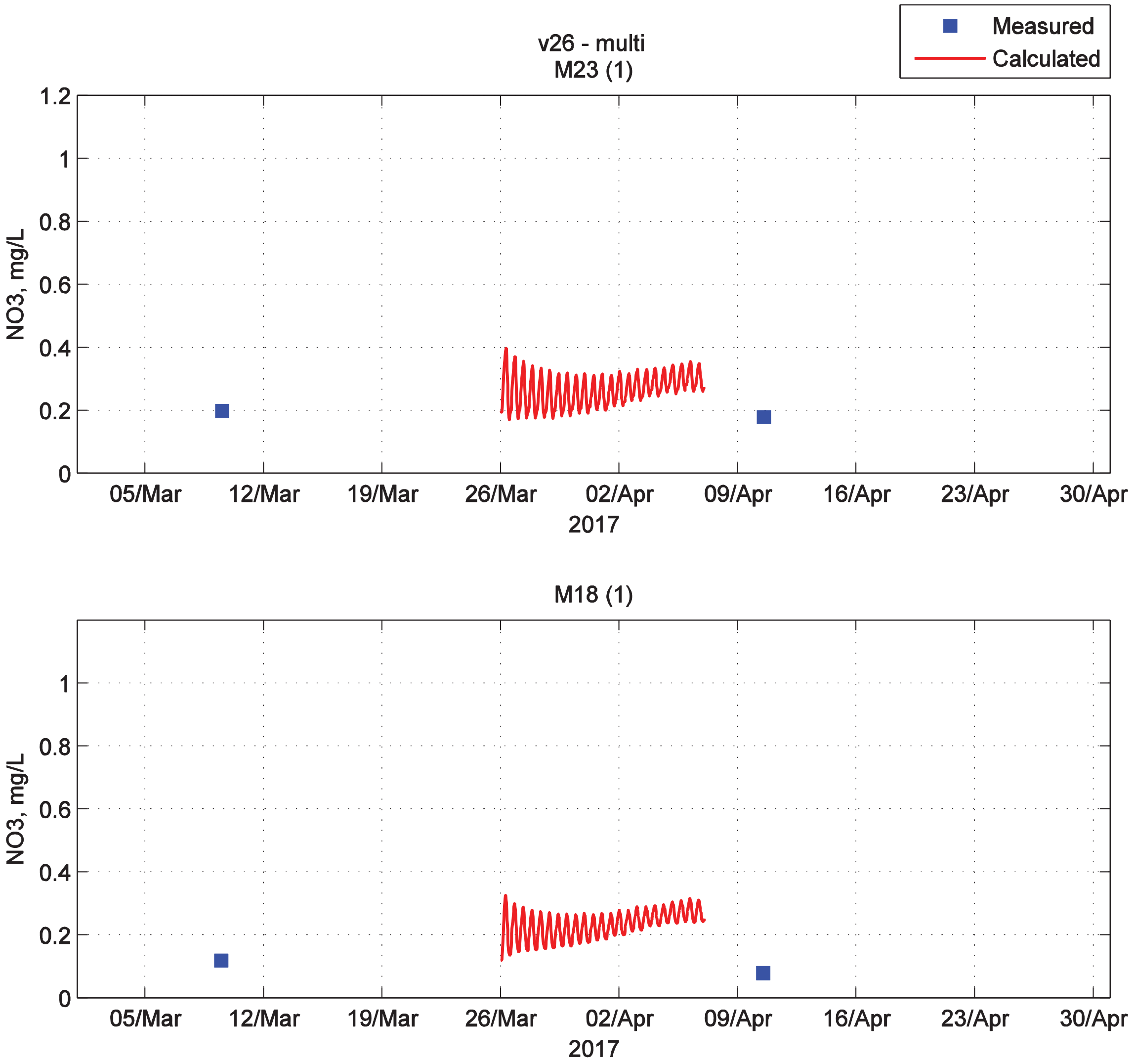

■ Measured
Calculated
v26 - multi
AC (1)
NCF6 (1)
IC (1)
NO3, mg/L
0
0.2
0.4
0.6
0.8
1
1.2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

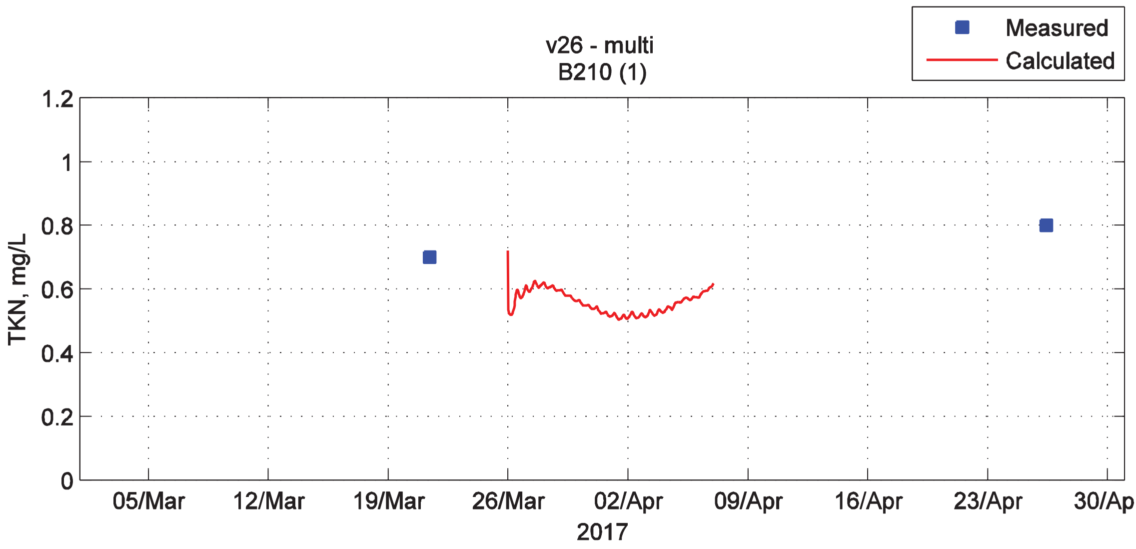

Measured
Calculated
v26 - multi
NAV (1)
NO3, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
HB (1)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
BRR (1)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

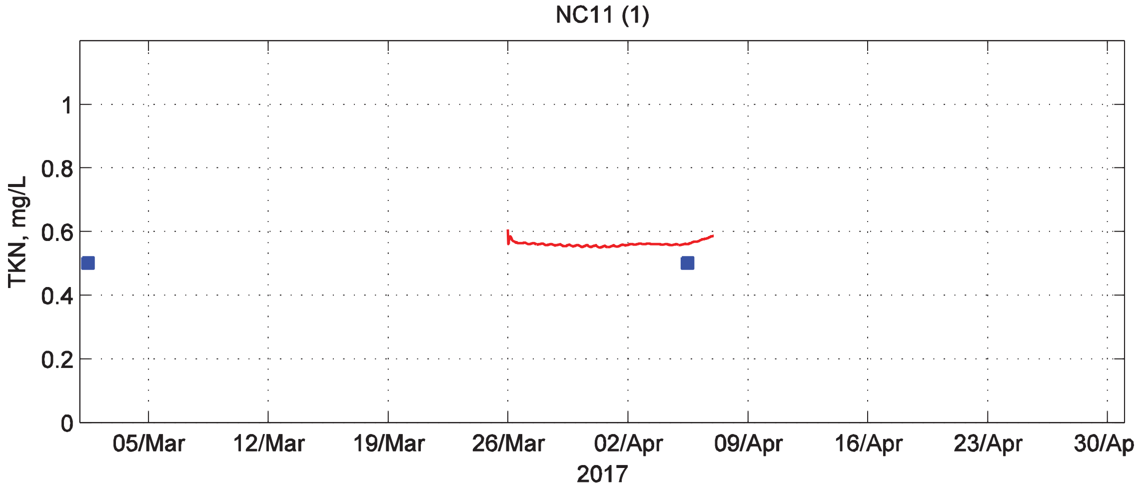

v26 - multi
M61 (1)

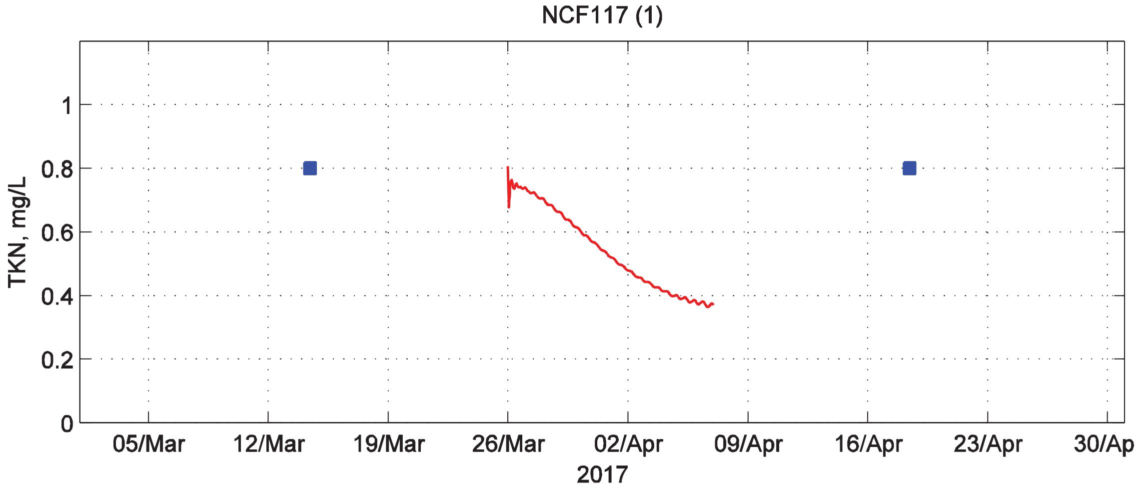

M54 (1)

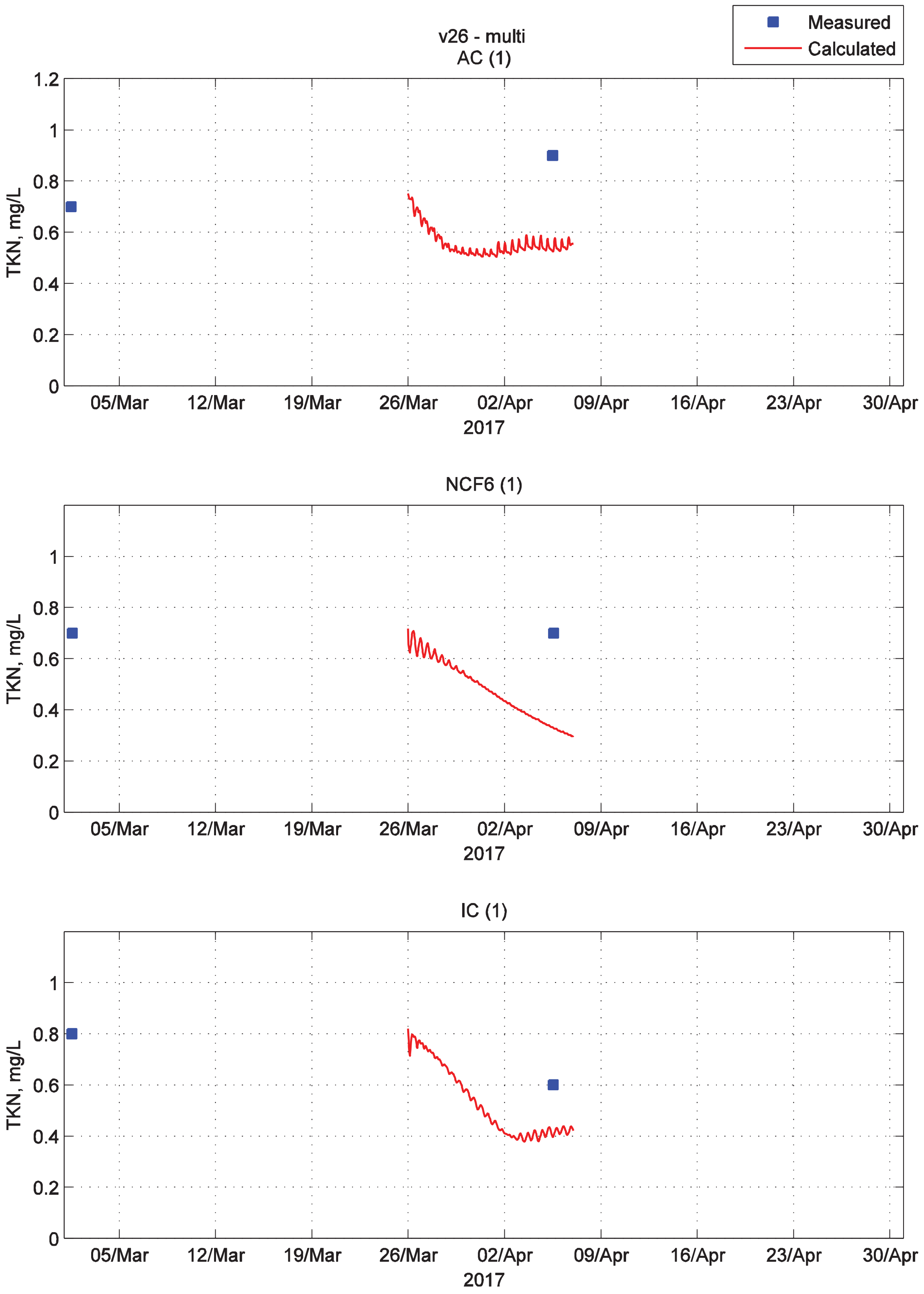

M35 (1)

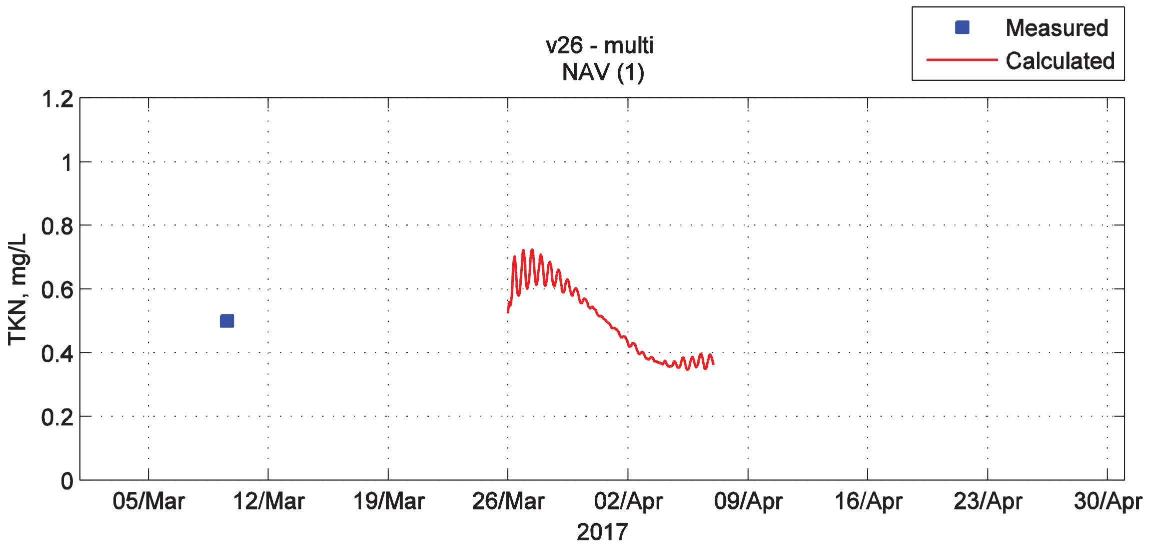

v26 - multi
M23 (1)
■ Measured
Calculated
NO3, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M18 (1)
NO3, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

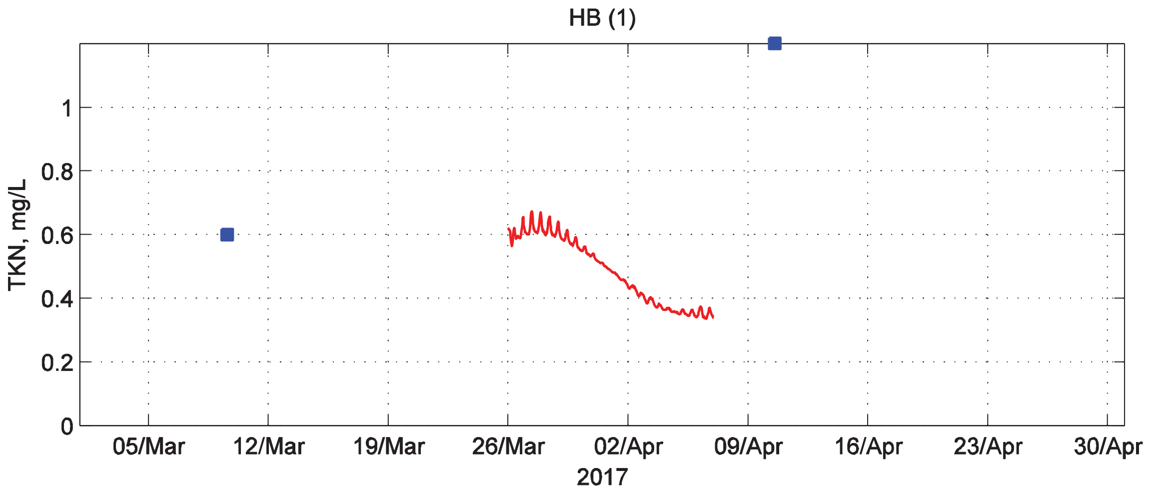

Measured
Calculated
v26 - multi
B210 (1)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
1.2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

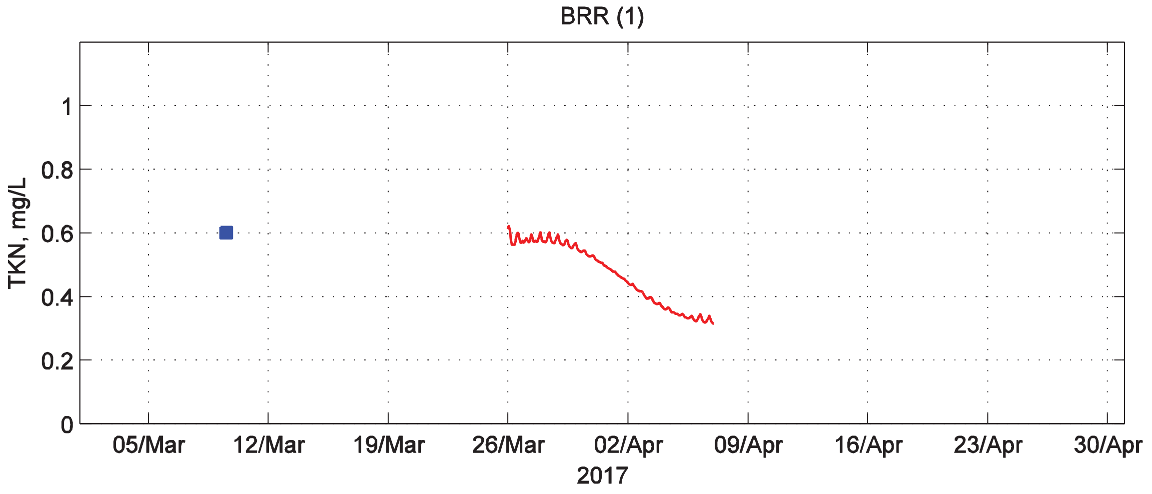

NC11 (1)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

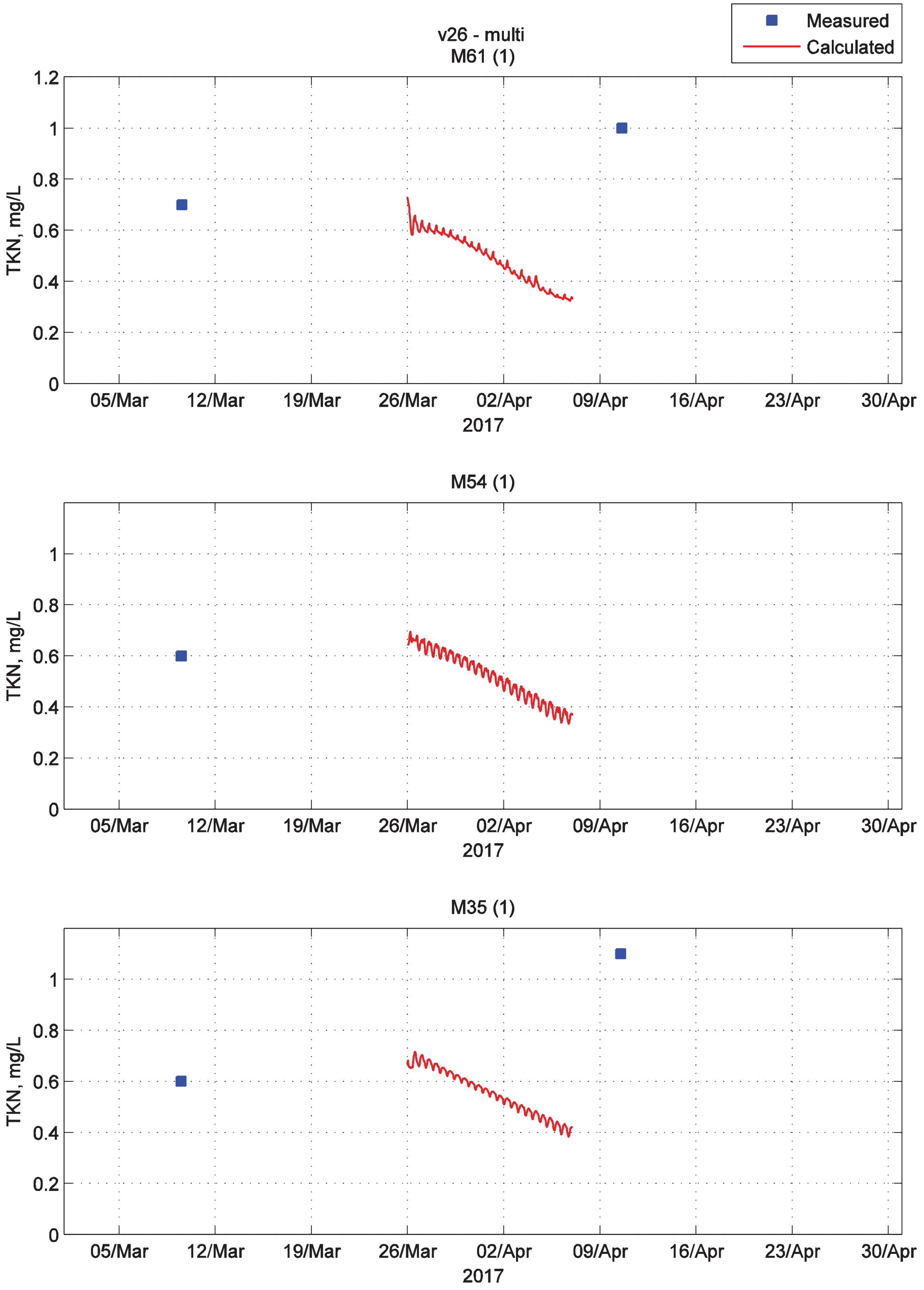

NCF117 (1)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

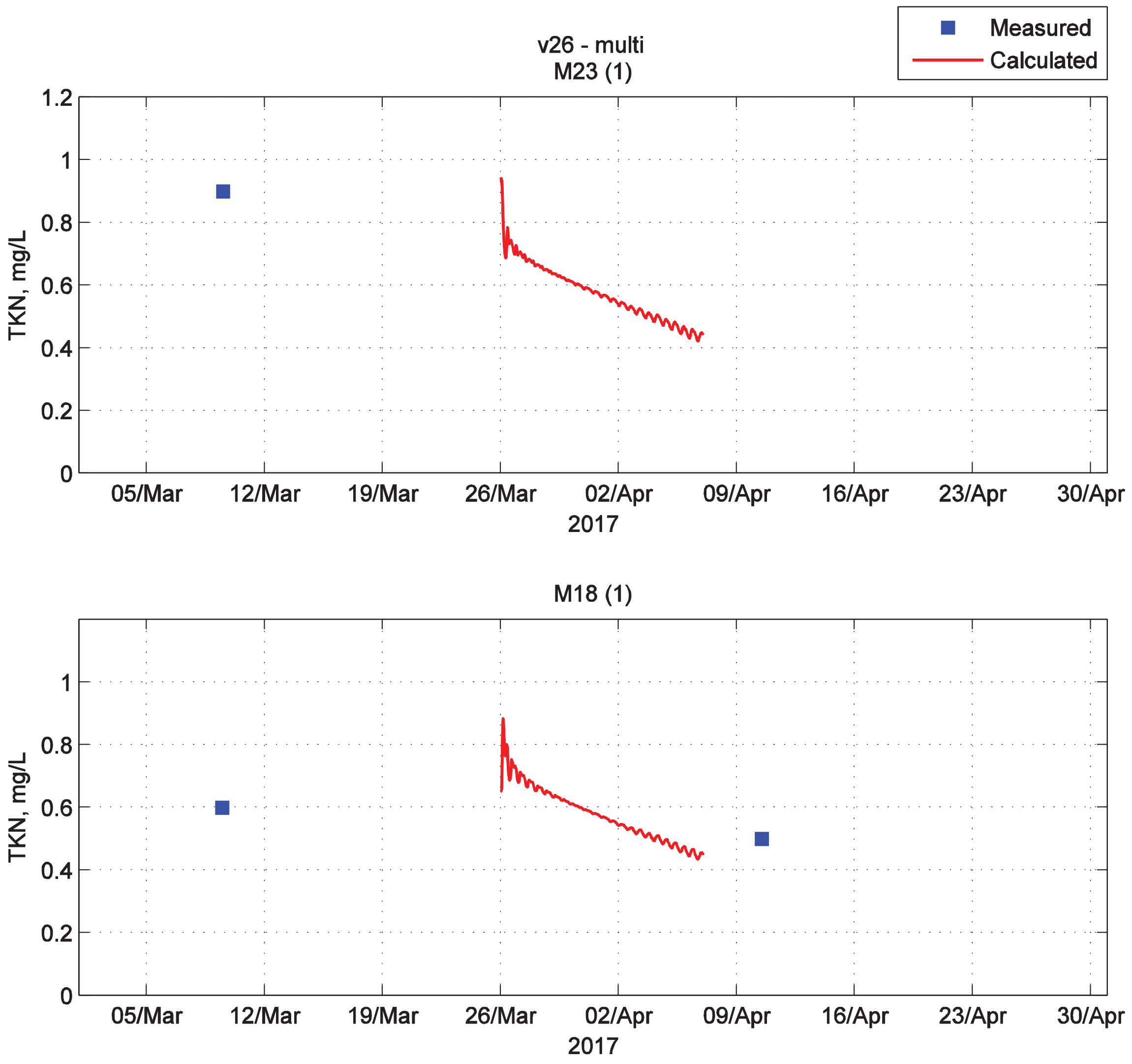

Measured
Calculated
v26 - multi
AC (1)
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
NCF6 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
IC (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

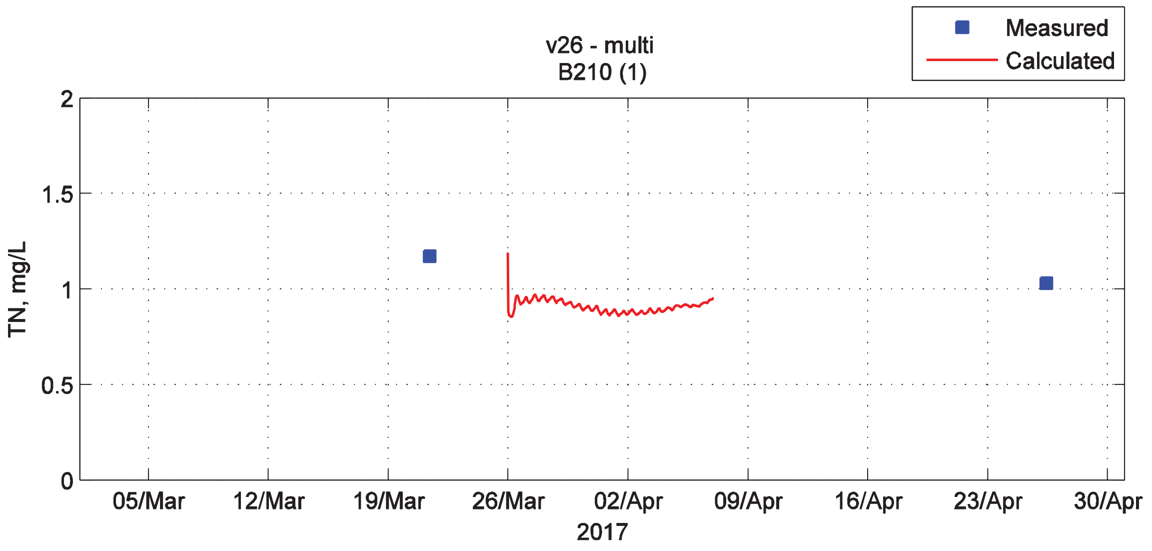

Measured
Calculated
v26 - multi
NAV (1)
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

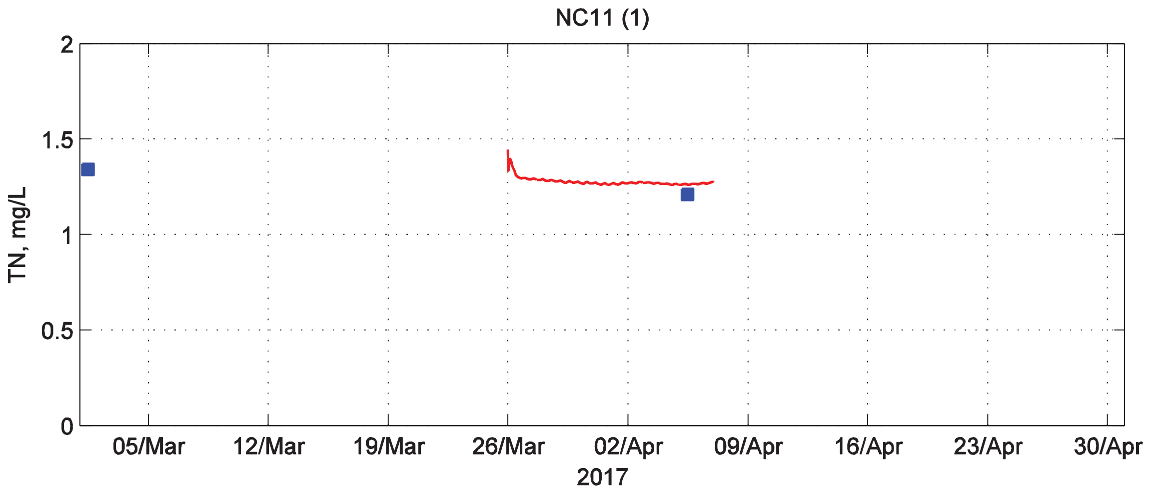

HB (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

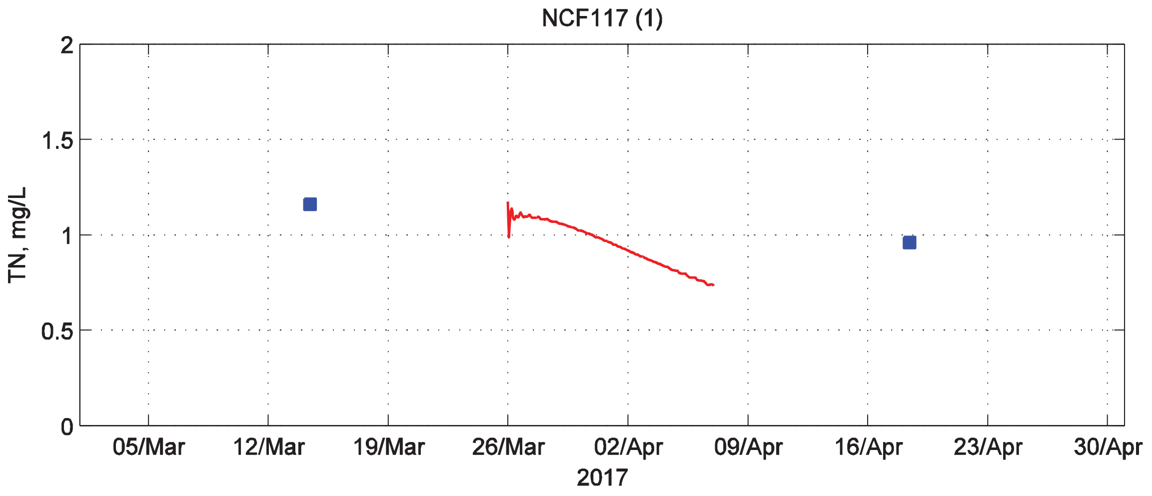

BRR (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

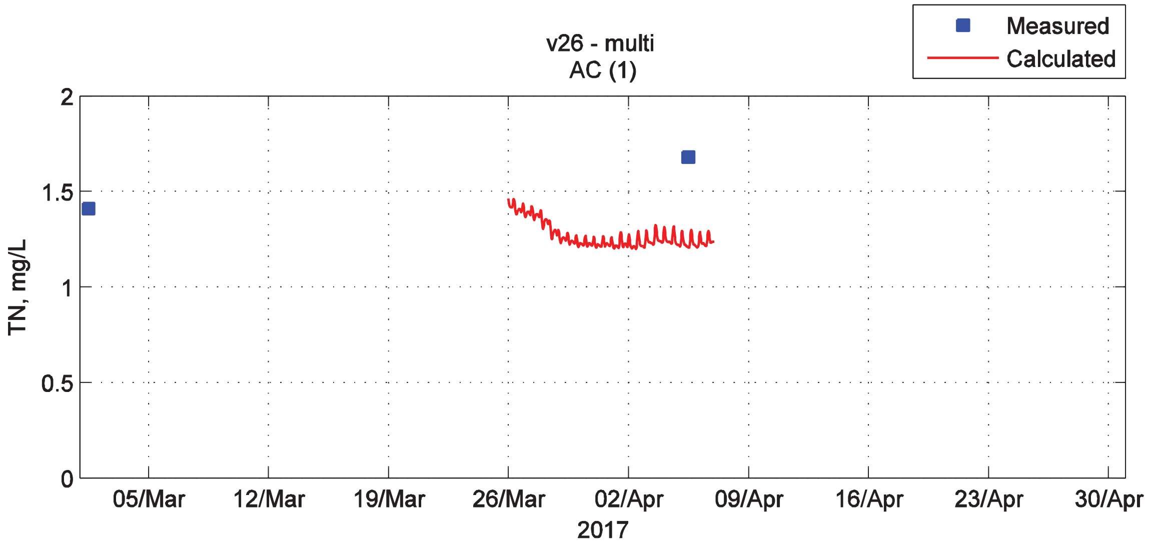

v26 - multi
M61 (1)
Measured
Calculated
TKN, mg/L
1.2
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M54 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M35 (1)
TKN, mg/L
1
0.8
0.6
0.4
0.2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

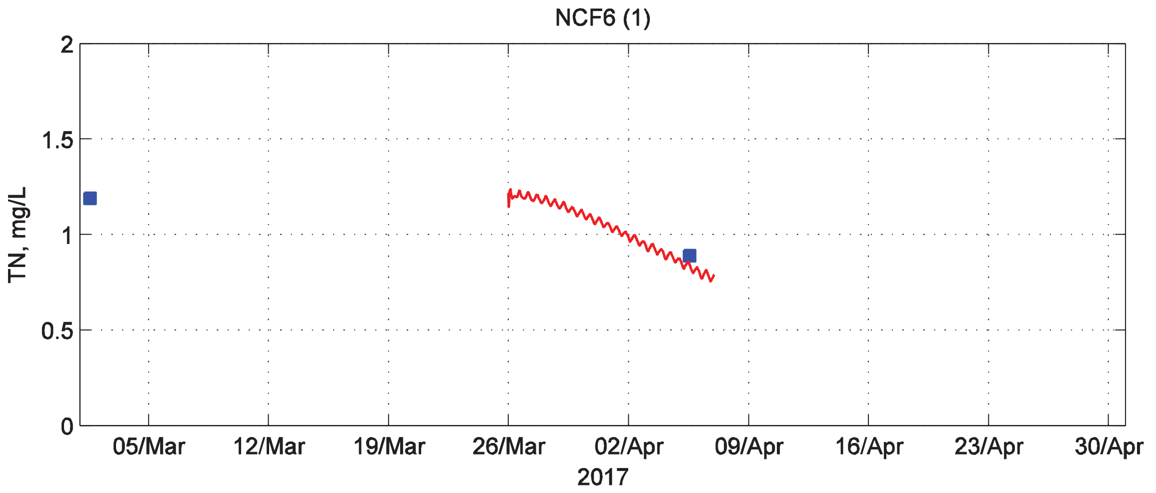

Measured
Calculated
v26 - multi
M23 (1)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
1.2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M18 (1)
TKN, mg/L
0
0.2
0.4
0.6
0.8
1
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

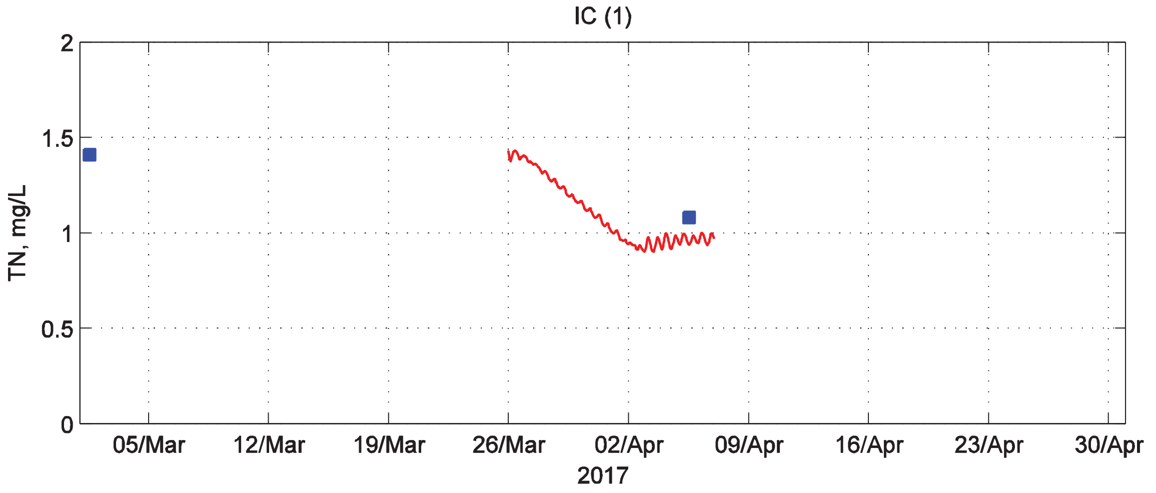

v26 - multi
B210 (1)
■ Measured
Calculated
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

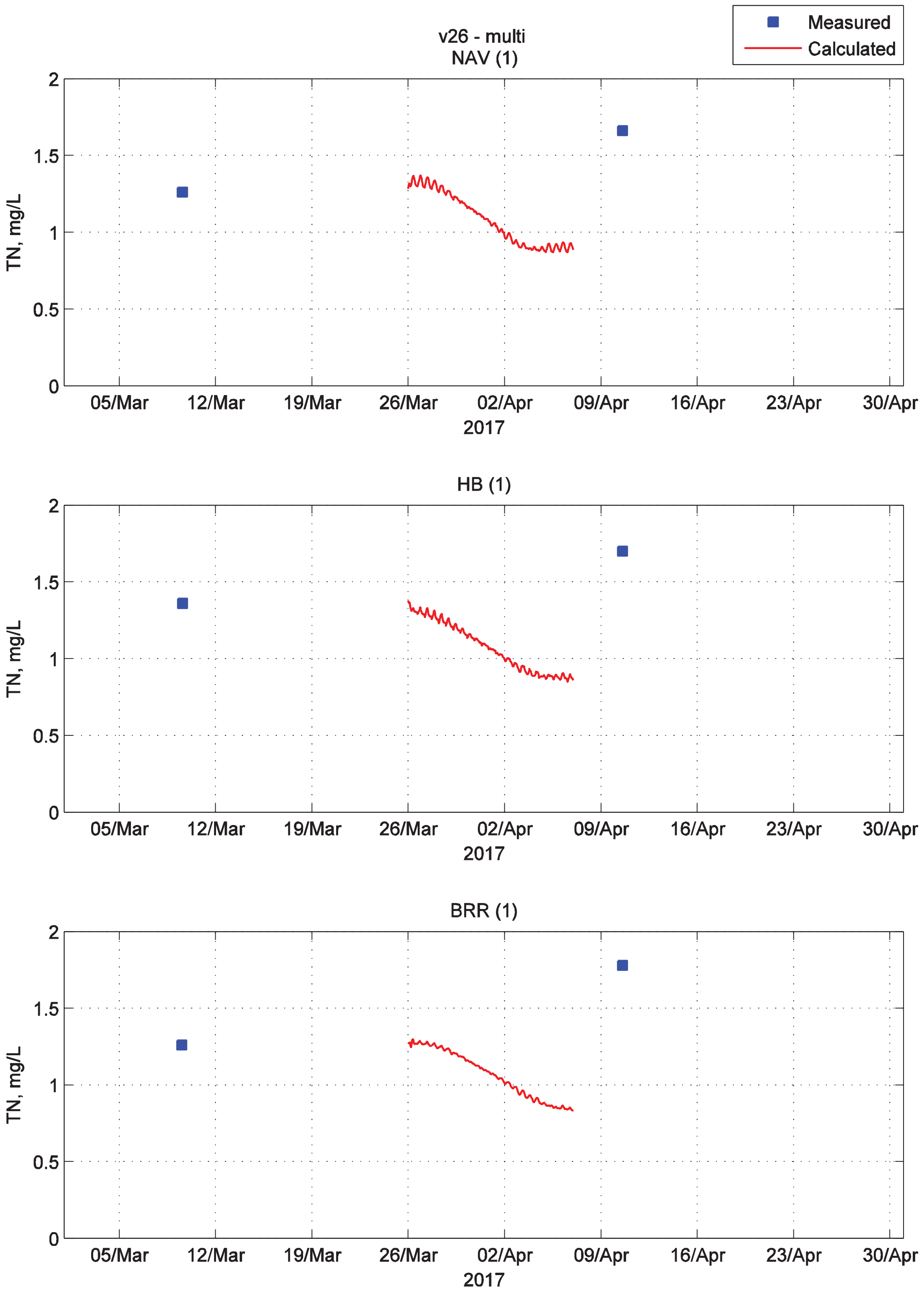

NC11 (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

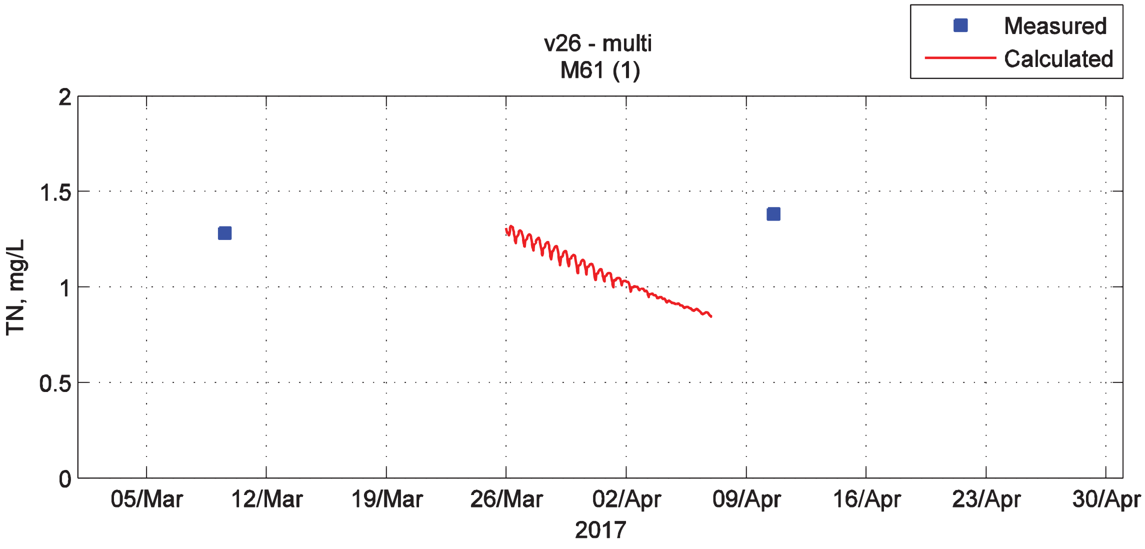

NCF117 (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

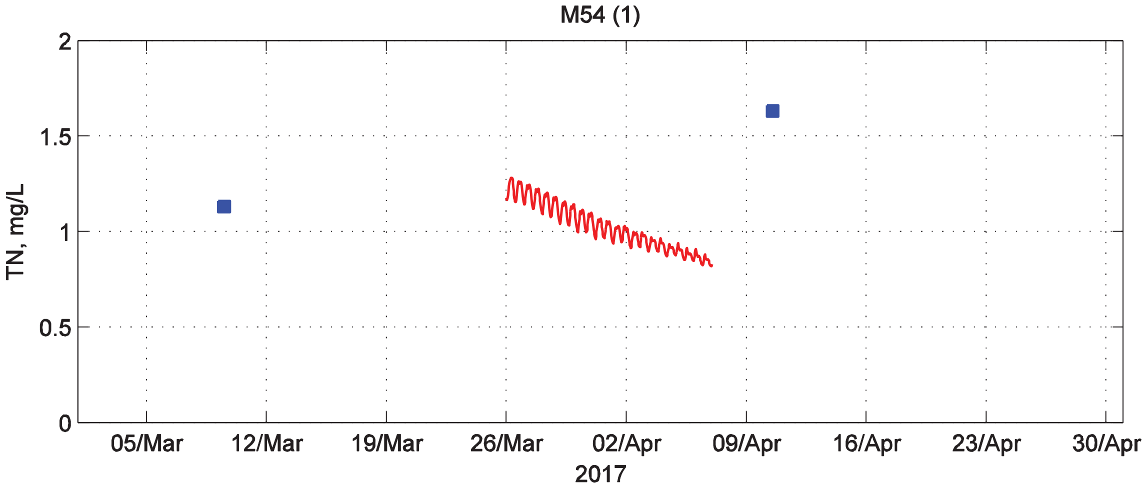

v26 - multi
AC (1)
■ Measured
Calculated
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

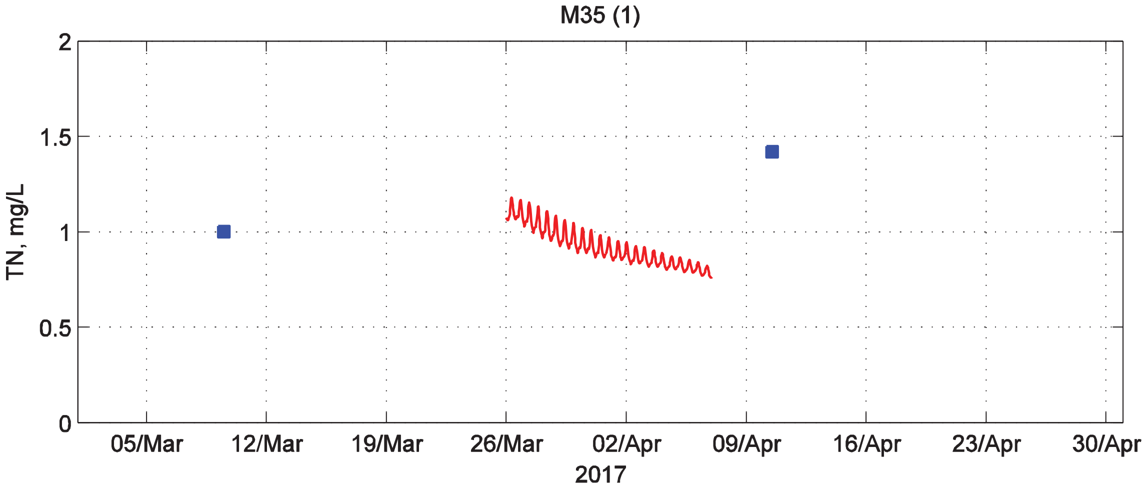

NCF6 (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

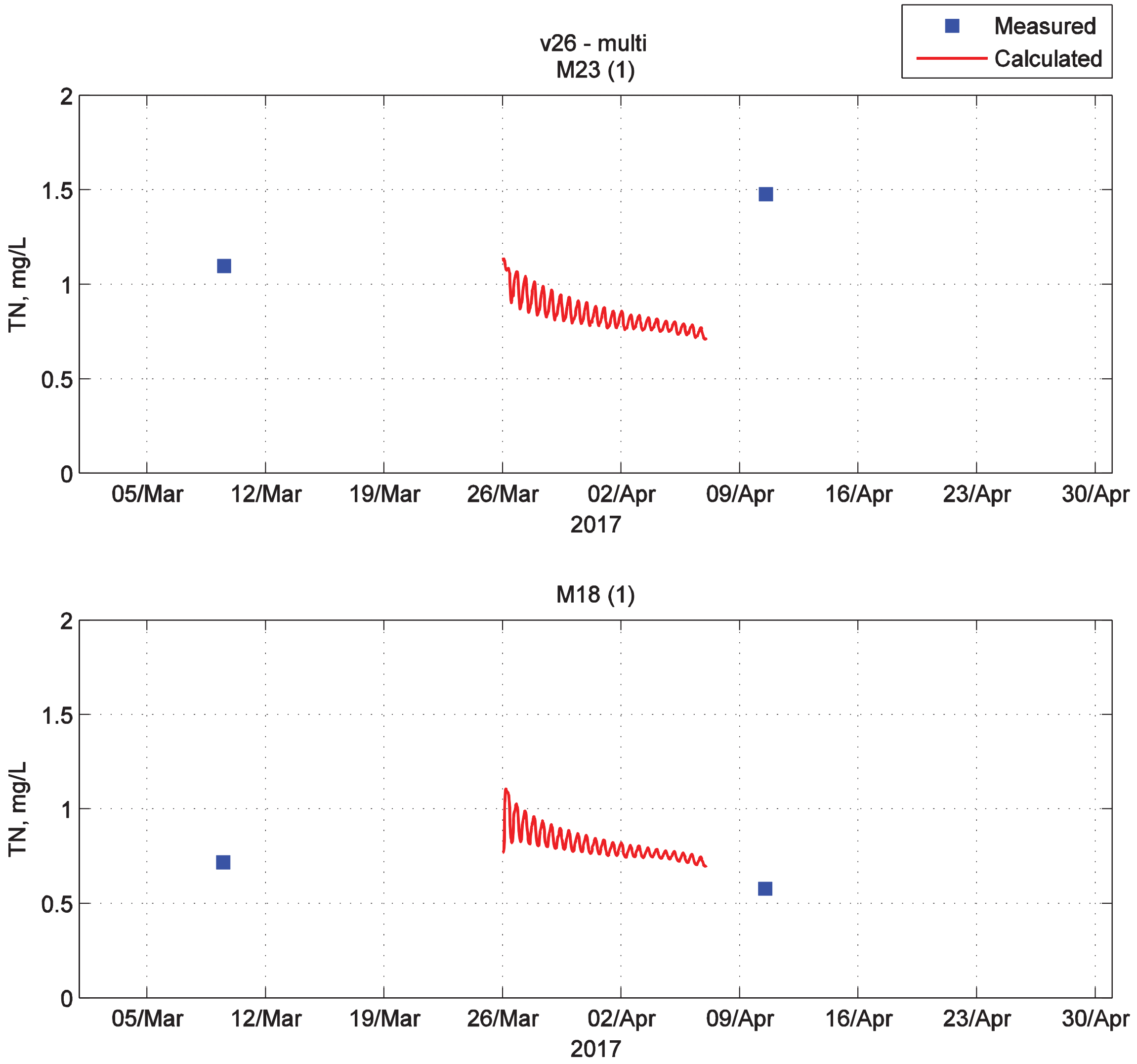

IC (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

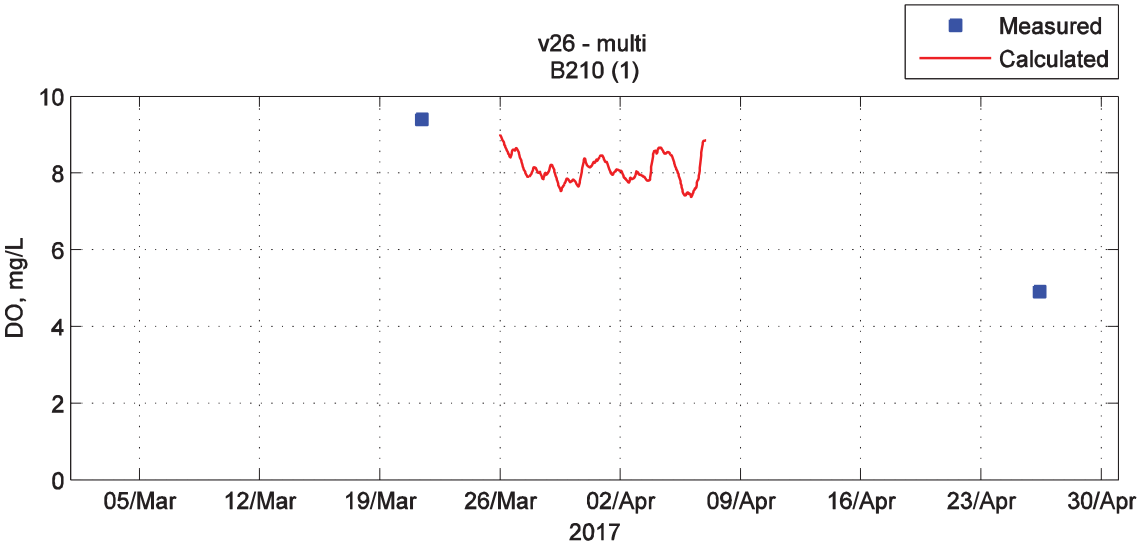

■ Measured
Calculated
v26 - multi
NAV (1)
HB (1)
BRR (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

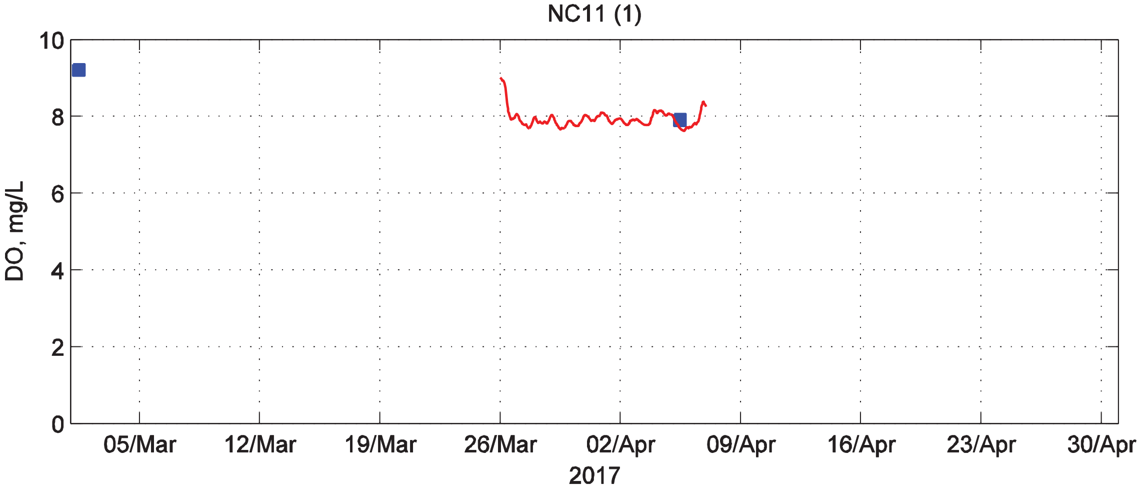

Measured
Calculated
v26 - multi
M61 (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

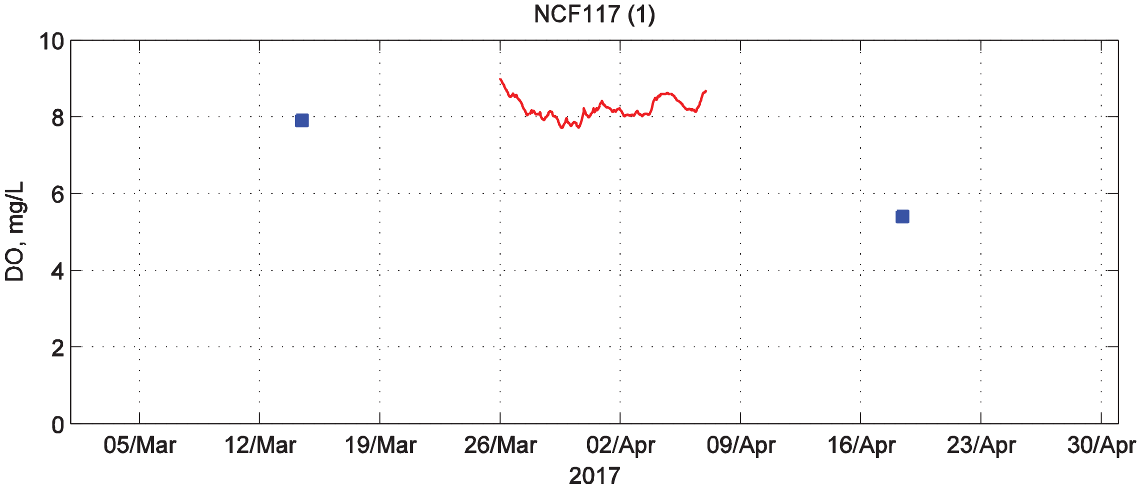

M54 (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

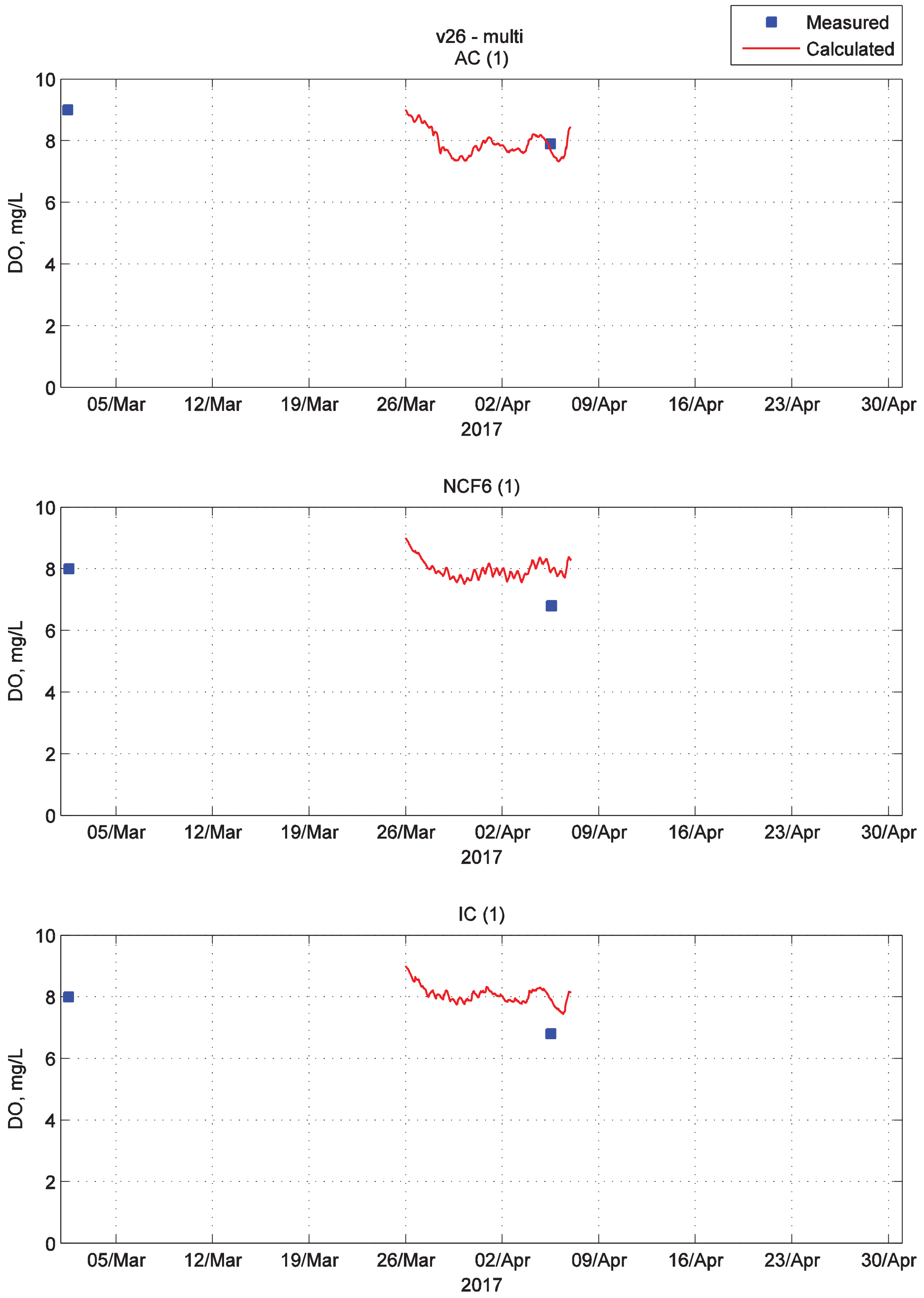

M35 (1)
TN, mg/L
0
0.5
1
1.5
2
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

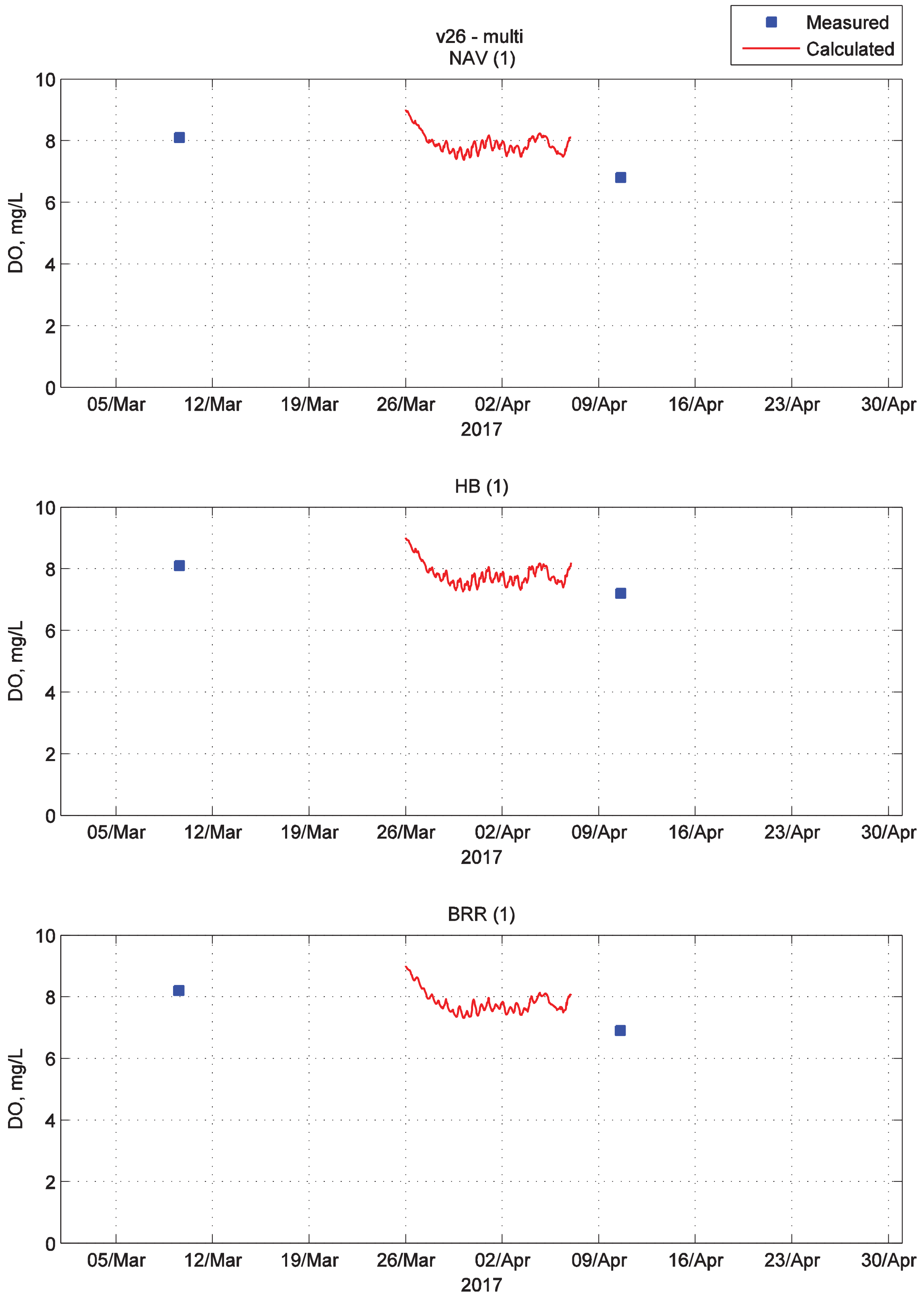

■ Measured
Calculated
v26 - multi
M23 (1)
TN, mg/L
2
1.5
1
0.5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M18 (1)
TN, mg/L
2
1.5
1
0.5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

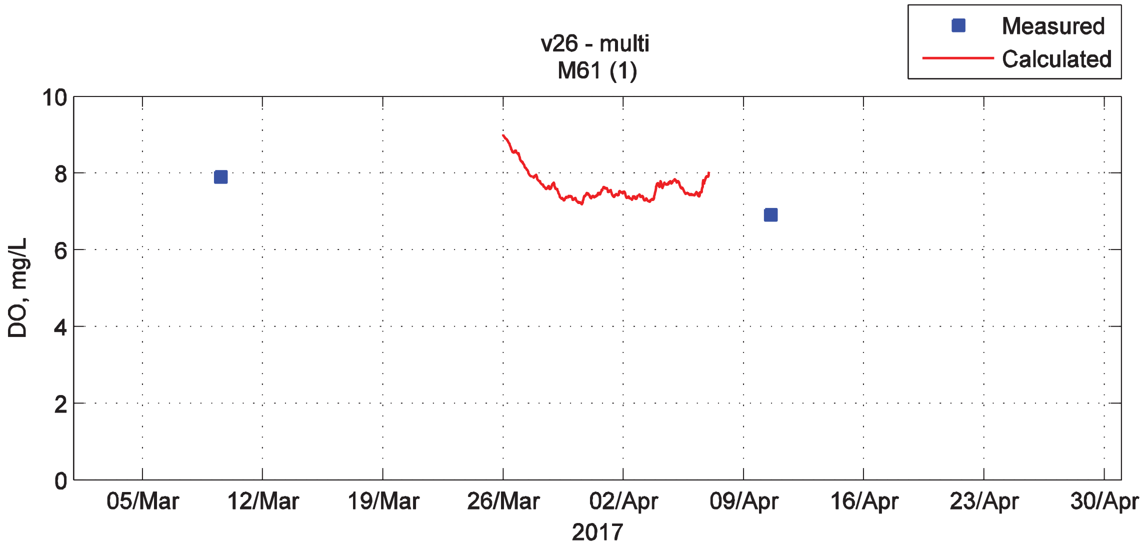

v26 - multi
B210 (1)

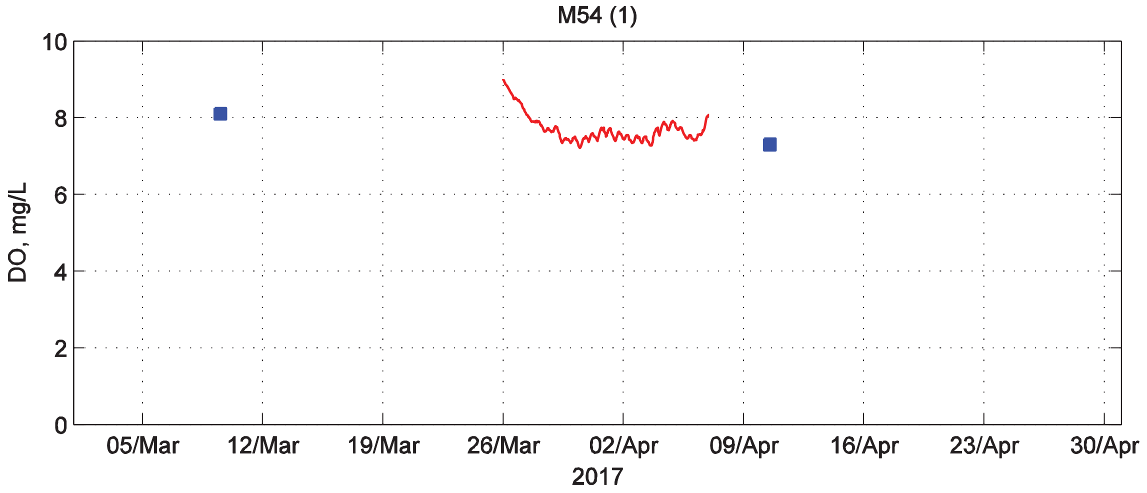

NC11 (1)

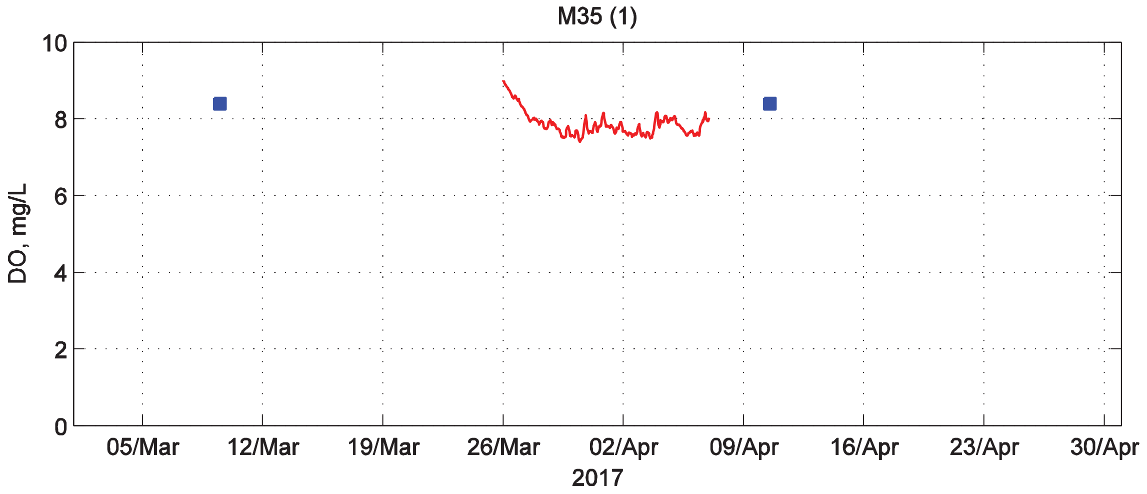

NCF117 (1)

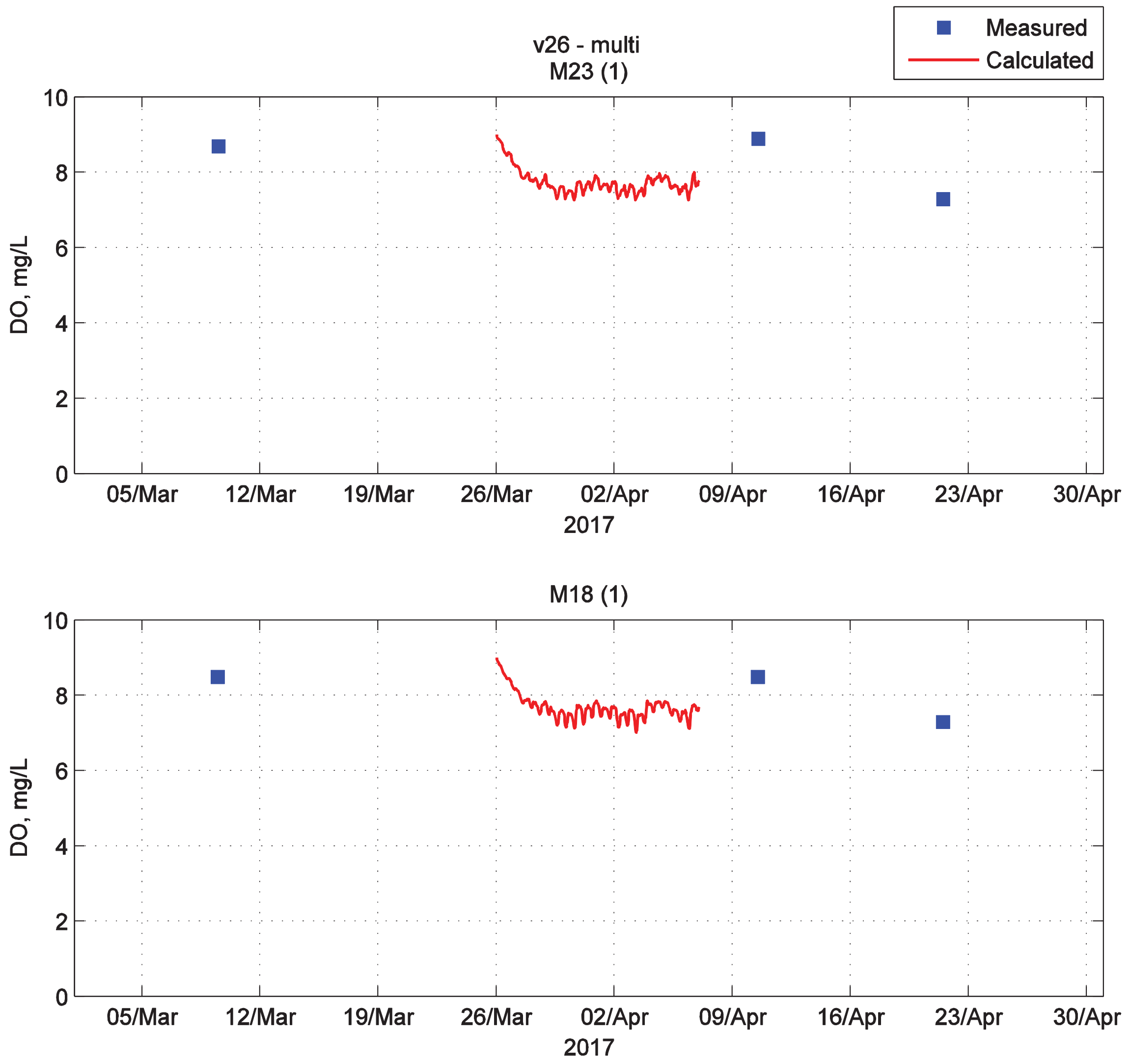

Measured
Calculated
v26 - multi
AC (1)
NCF6 (1)
IC (1)
DO, mg/L
0
2
4
6
8
10
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

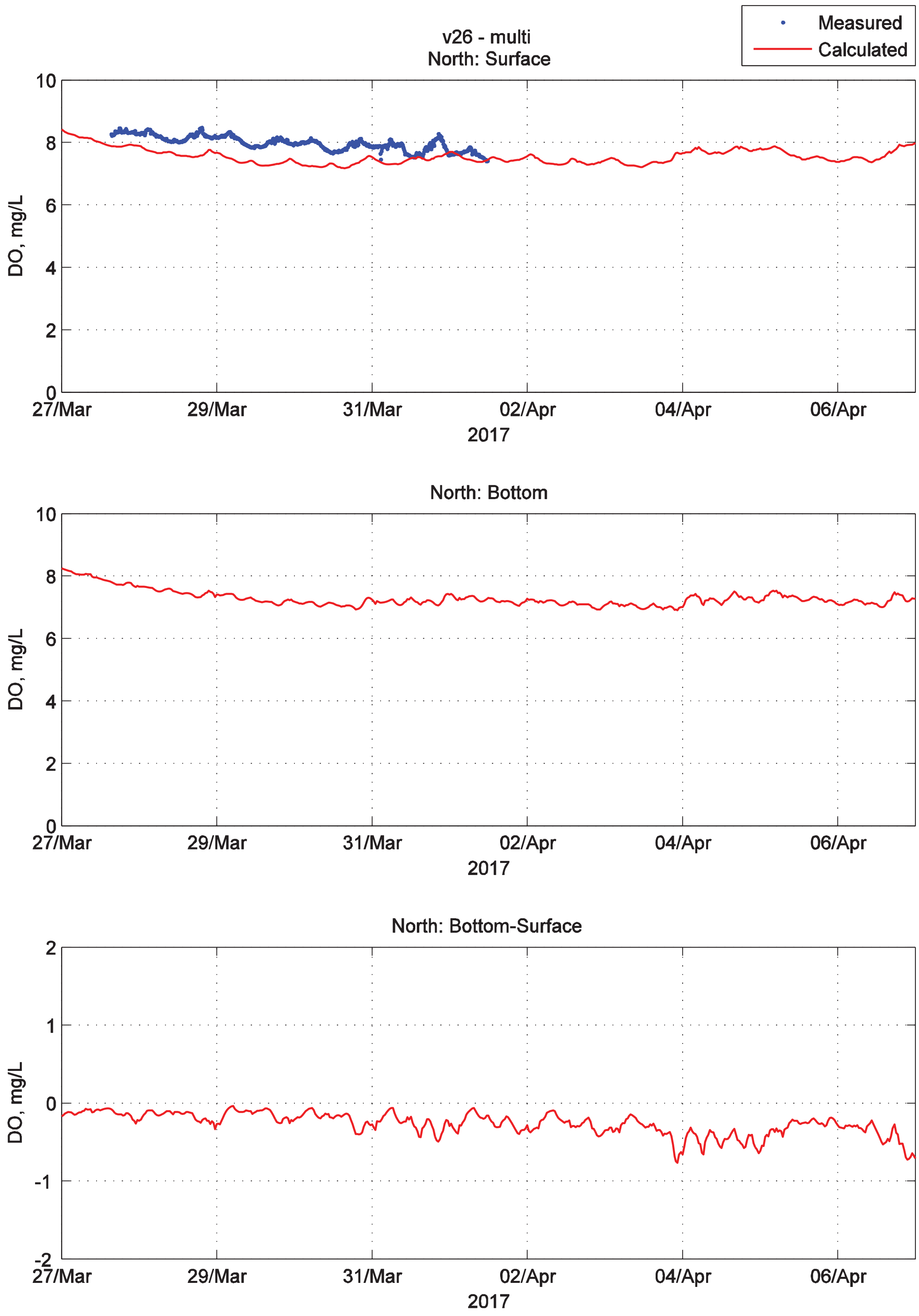

■ Measured
Calculated
v26 - multi
NAV (1)
HB (1)
BRR (1)
DO, mg/L
0
2
4
6
8
10
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

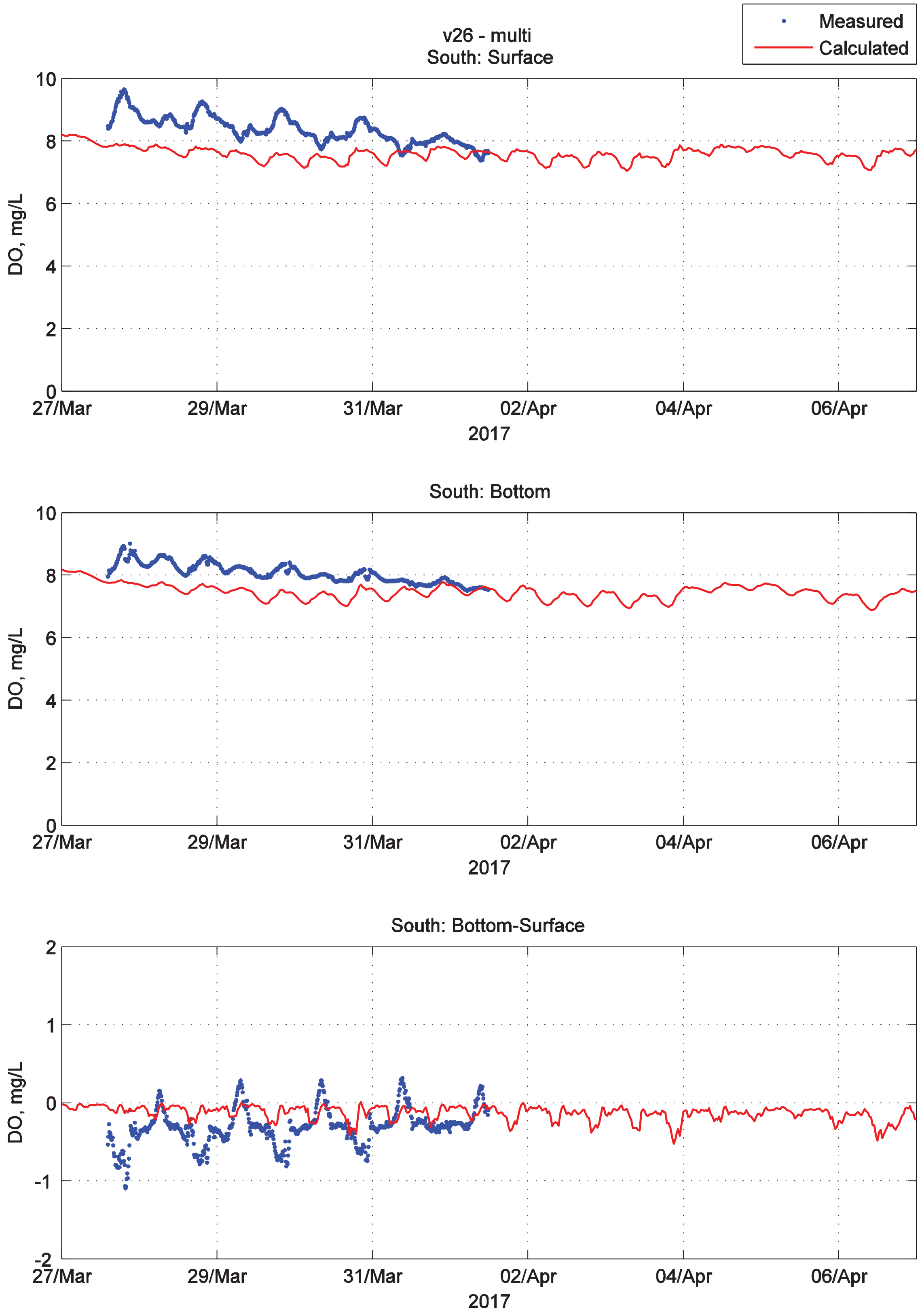

Measured
Calculated
v26 - multi
M61 (1)
DO, mg/L
10
8
6
4
2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

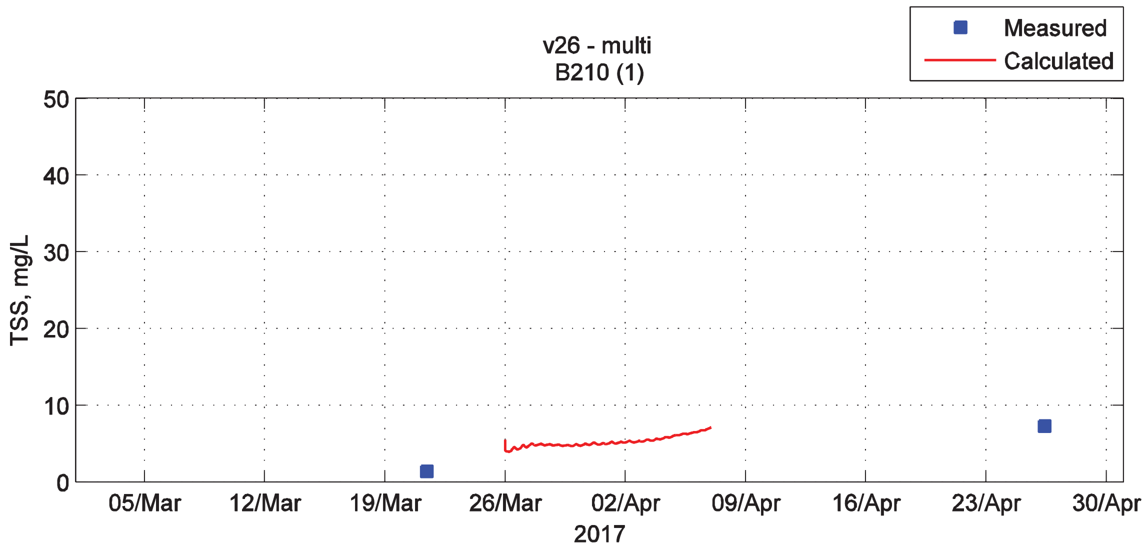

M54 (1)
DO, mg/L
10
8
6
4
2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

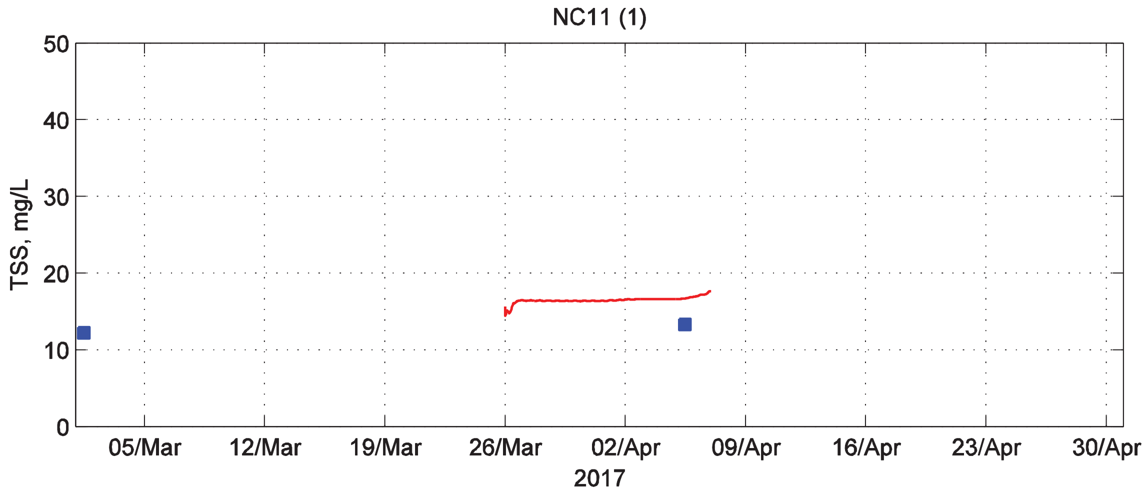

M35 (1)
DO, mg/L
10
8
6
4
2
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

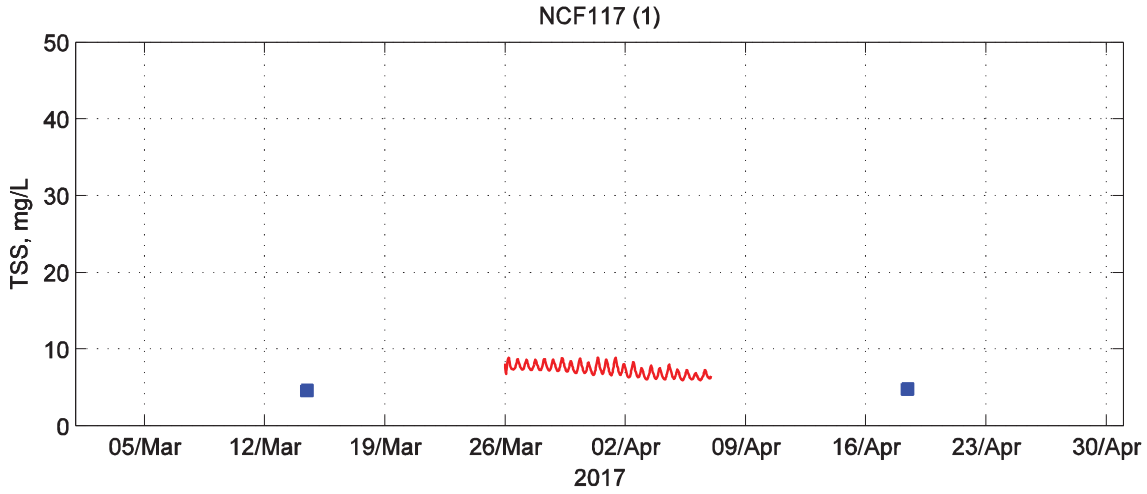

v26 - multi
M23 (1)
Measured
Calculated
DO, mg/L
0
2
4
6
8
10
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
M18 (1)
DO, mg/L
0
2
4
6
8
10
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

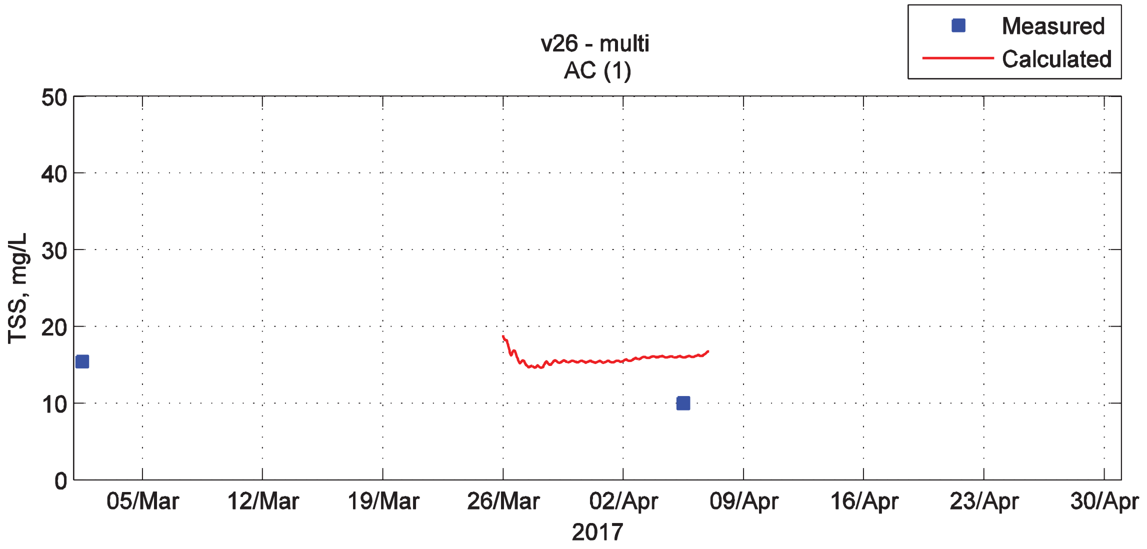

Measured
Calculated
v26 - multi
North: Surface
DO, mg/L
10
8
6
4
2
0
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017
North: Bottom
DO, mg/L
10
8
6
4
2
0
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017
North: Bottom-Surface
DO, mg/L
2
1
0
-1
-2
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017

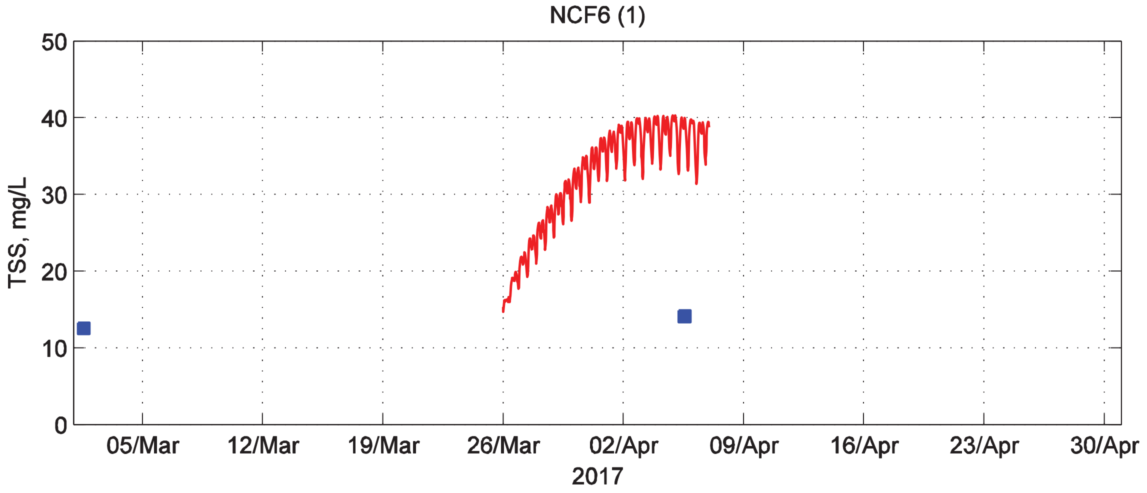

Measured
Calculated
v26 - multi
South: Surface
10
8
6
4
2
0
DO, mg/L
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017
South: Bottom
10
8
6
4
2
0
DO, mg/L
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017
South: Bottom-Surface
2
1
0
-1
-2
DO, mg/L
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017

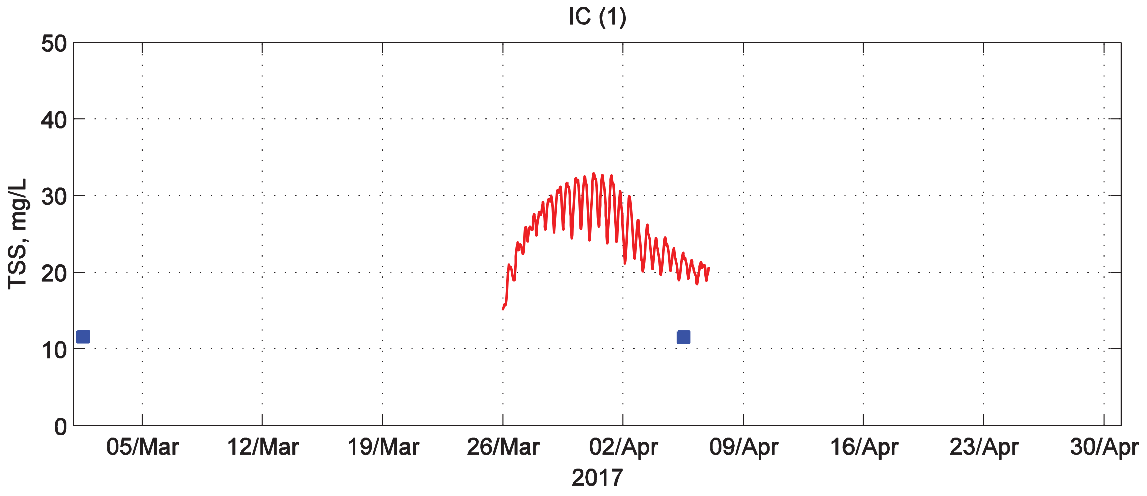

v26 - multi
B210 (1)
Measured
Calculated
TSS, mg/L
50
40
30
20
10
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

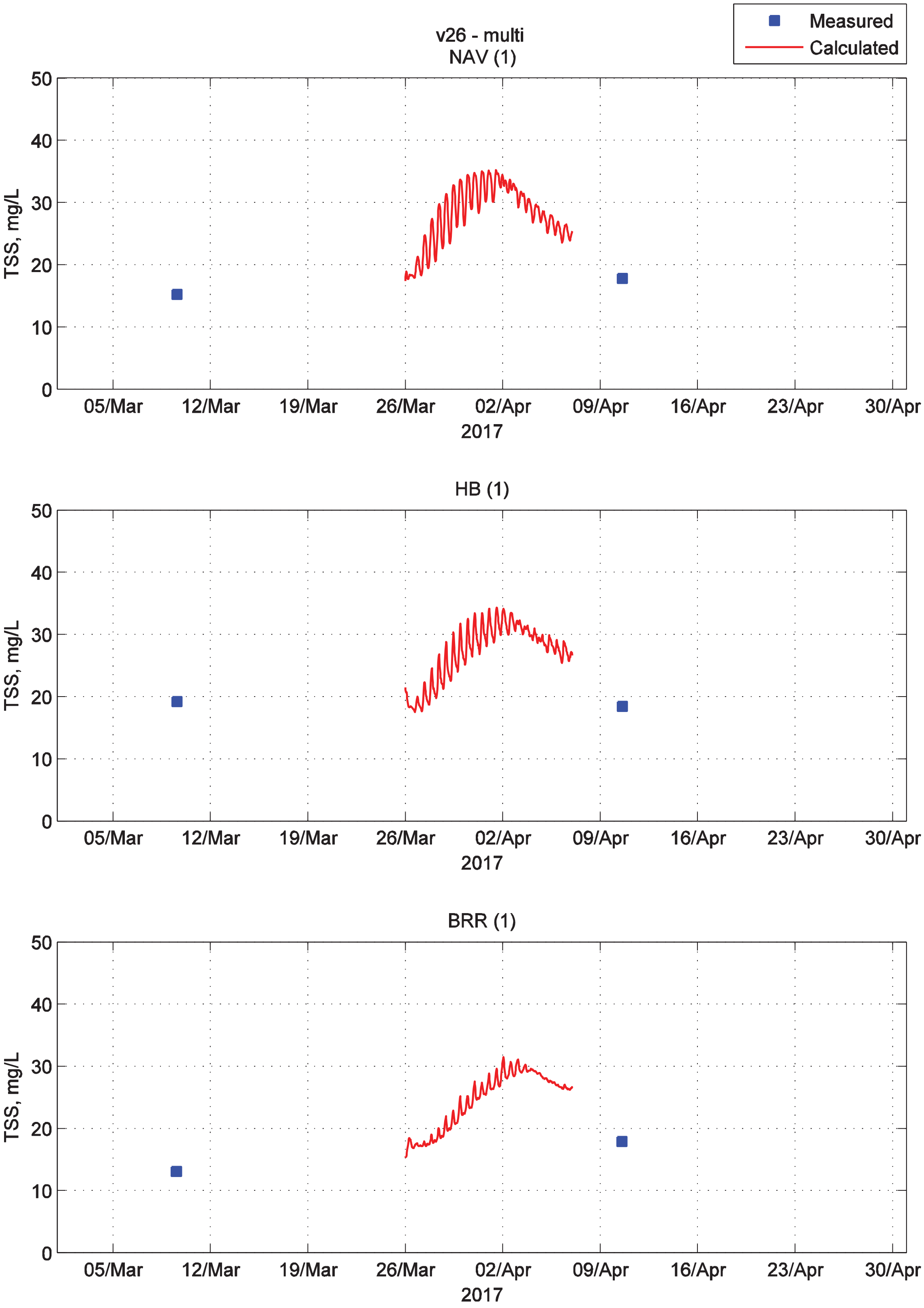

NC11 (1)
TSS, mg/L
50
40
30
20
10
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

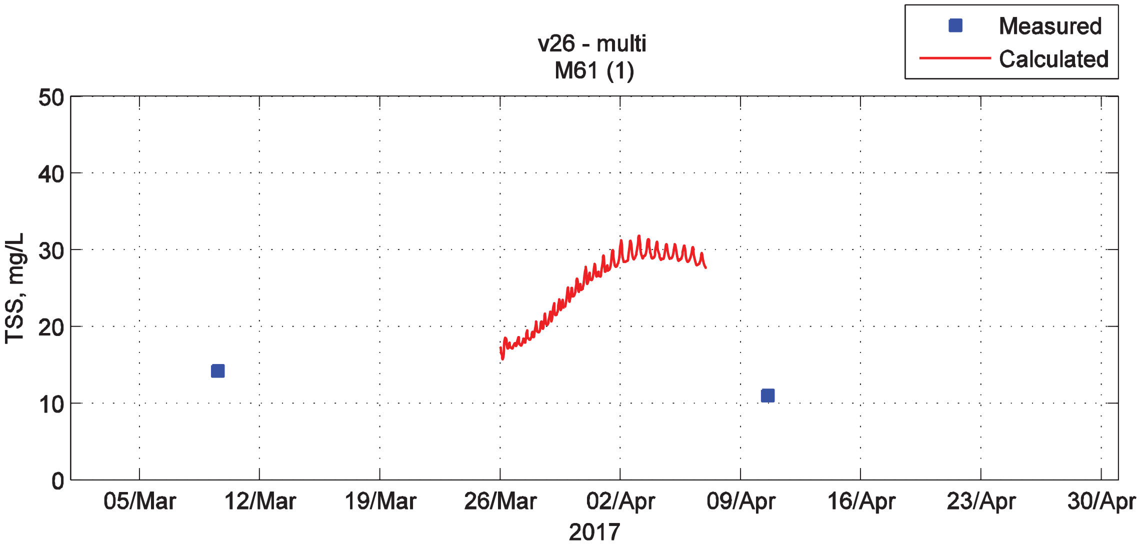

NCF117 (1)
TSS, mg/L
50
40
30
20
10
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

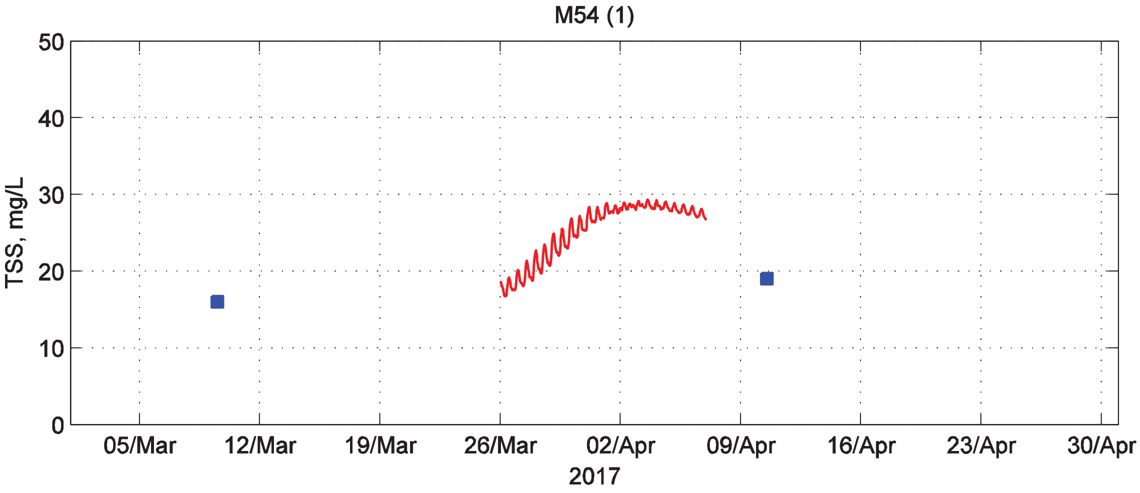

Measured
Calculated
v26 - multi
AC (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

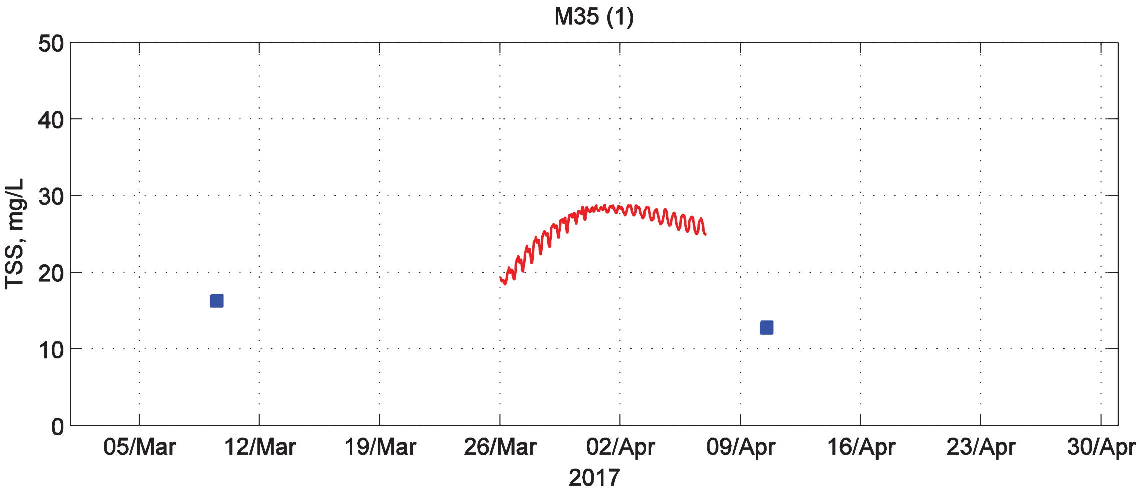

NCF6 (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

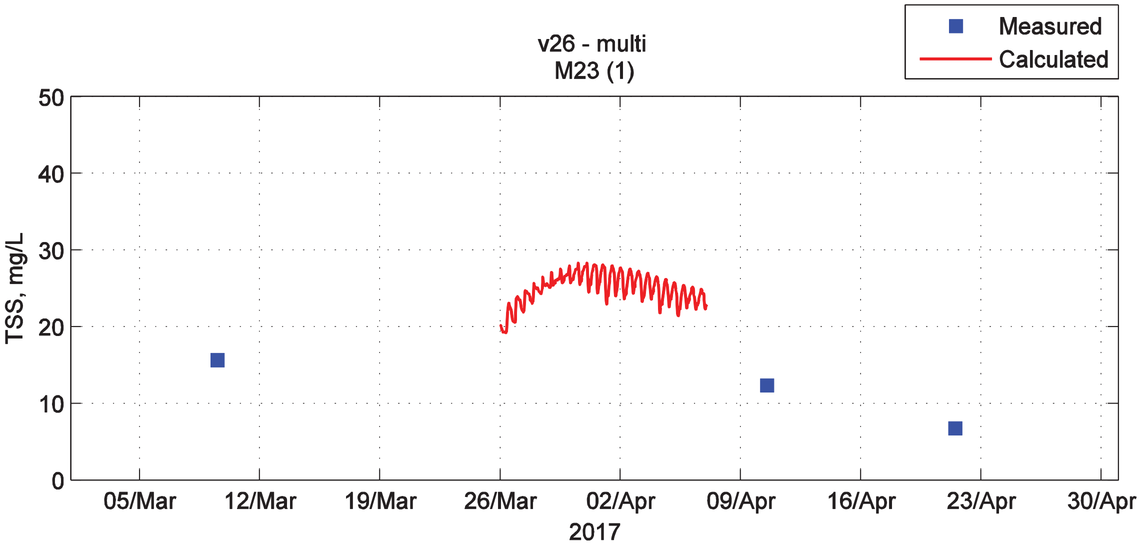

IC (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

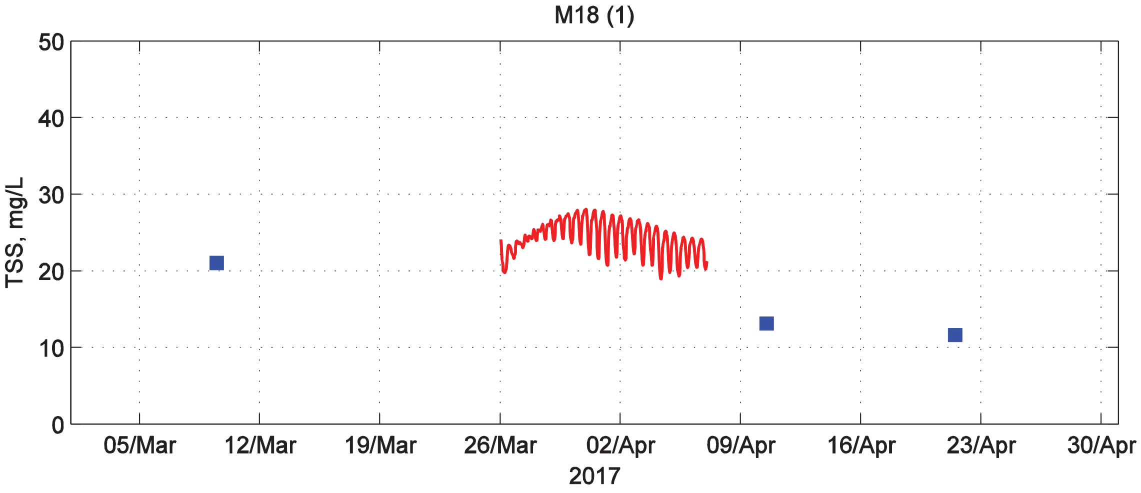

Measured
Calculated
v26 - multi
NAV (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
HB (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017
BRR (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

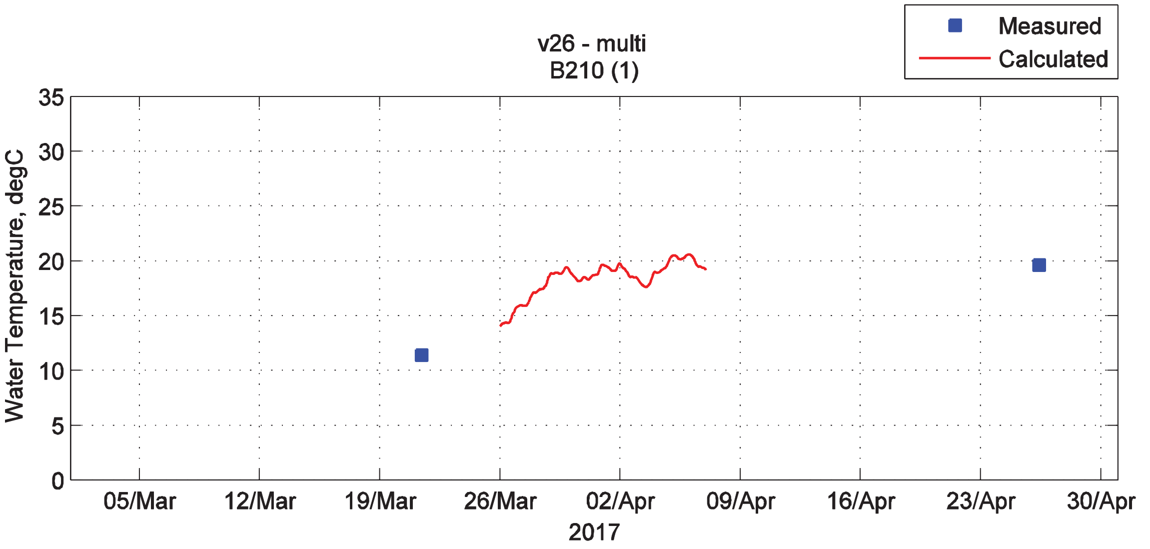

■ Measured
Calculated
v26 - multi
M61 (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

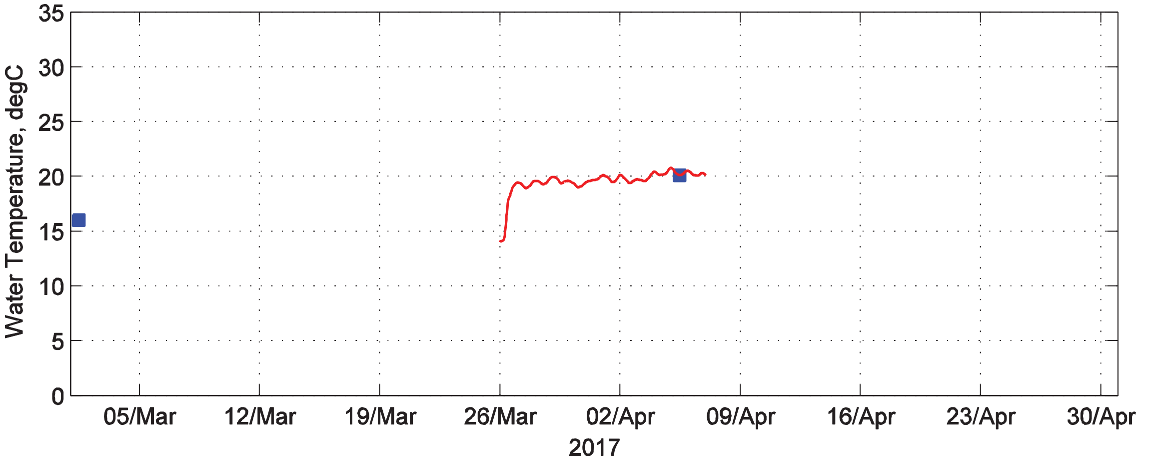

M54 (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

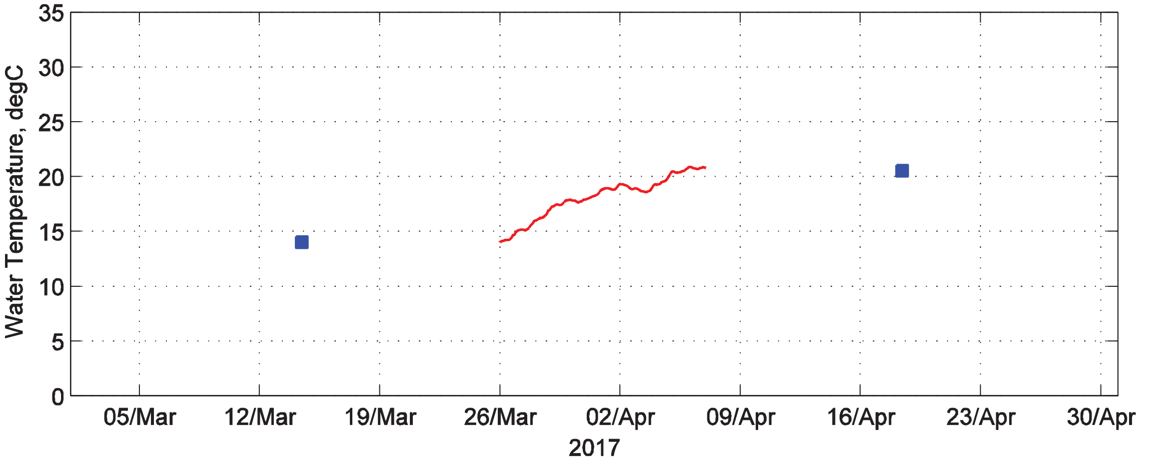

M35 (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

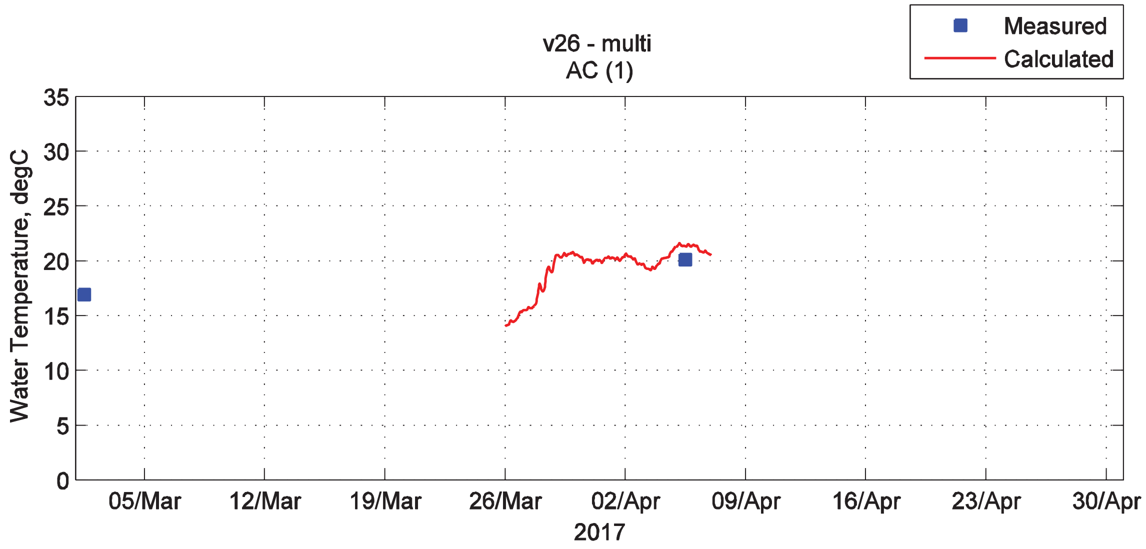

Measured
Calculated
v26 - multi
M23 (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

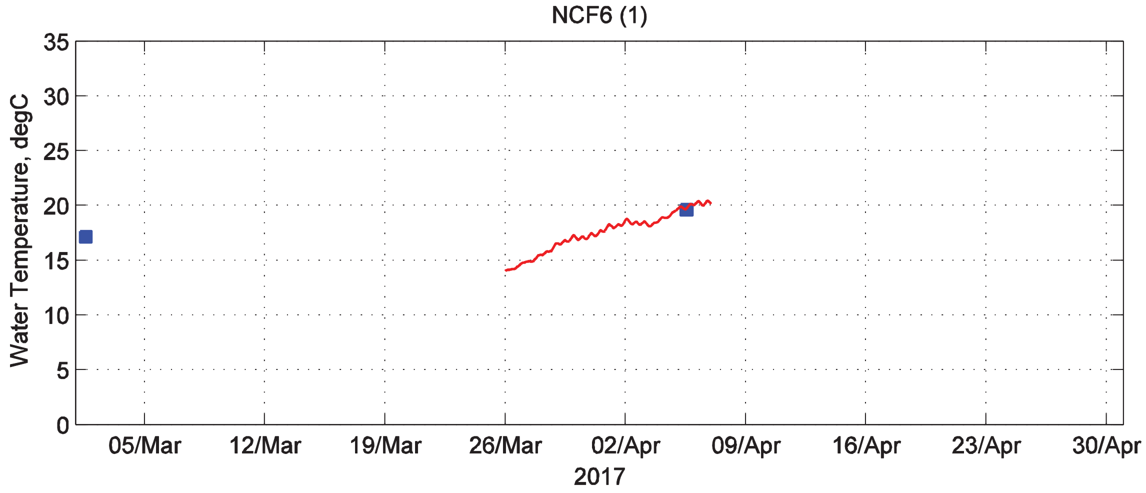

M18 (1)
TSS, mg/L
0
10
20
30
40
50
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

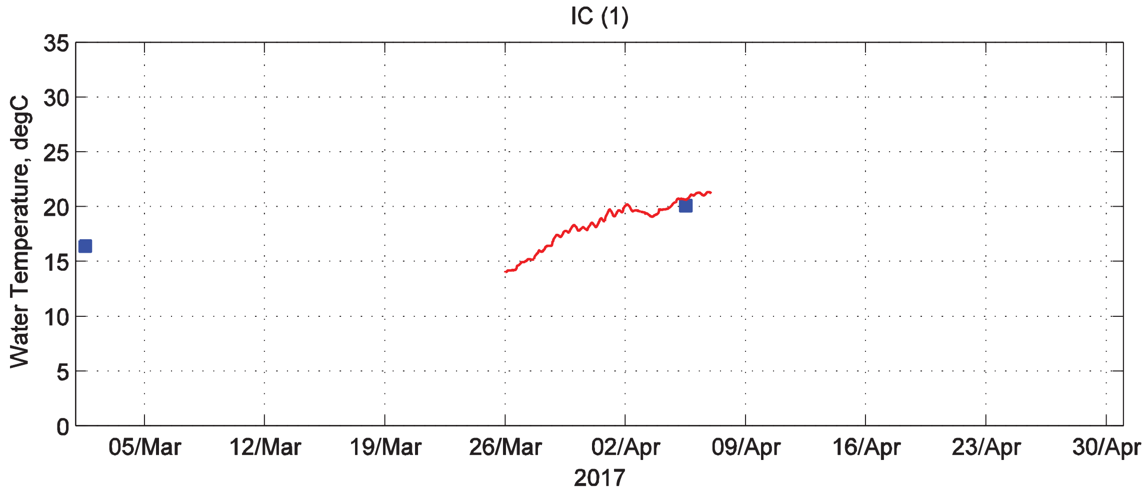

v26 - multi
B210 (1)

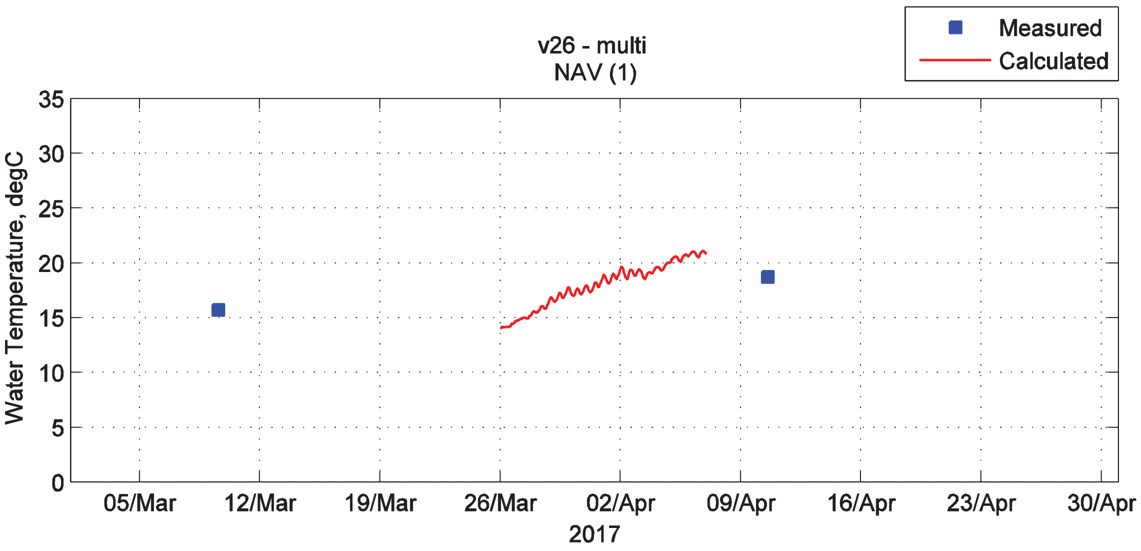

NC11 (1)

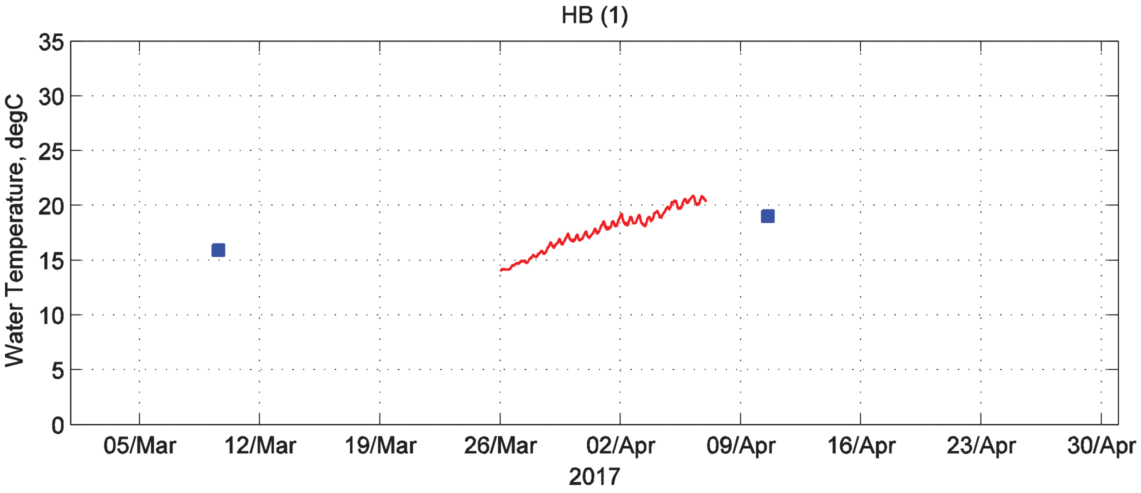

NCF117 (1)

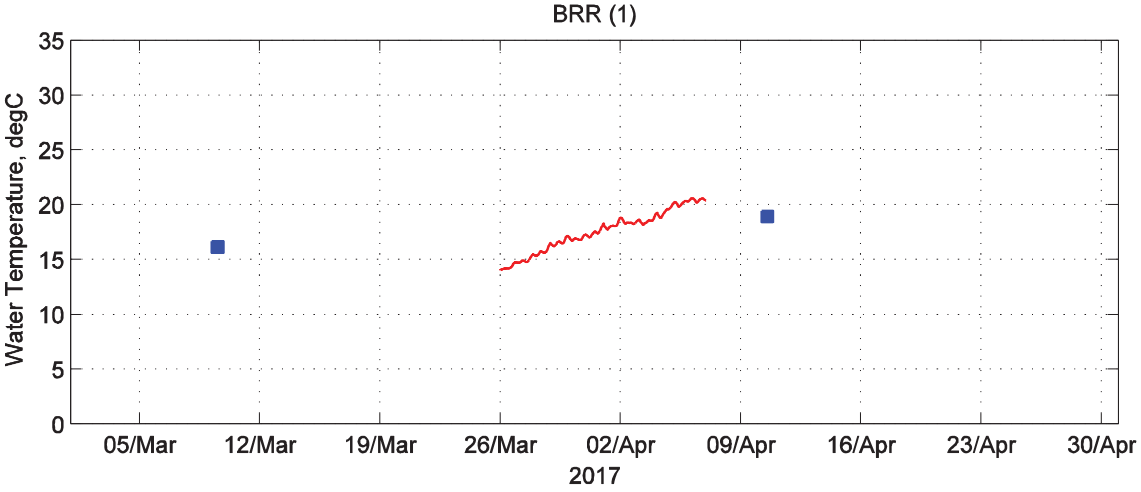

■ Measured
Calculated
v26 - multi
AC (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

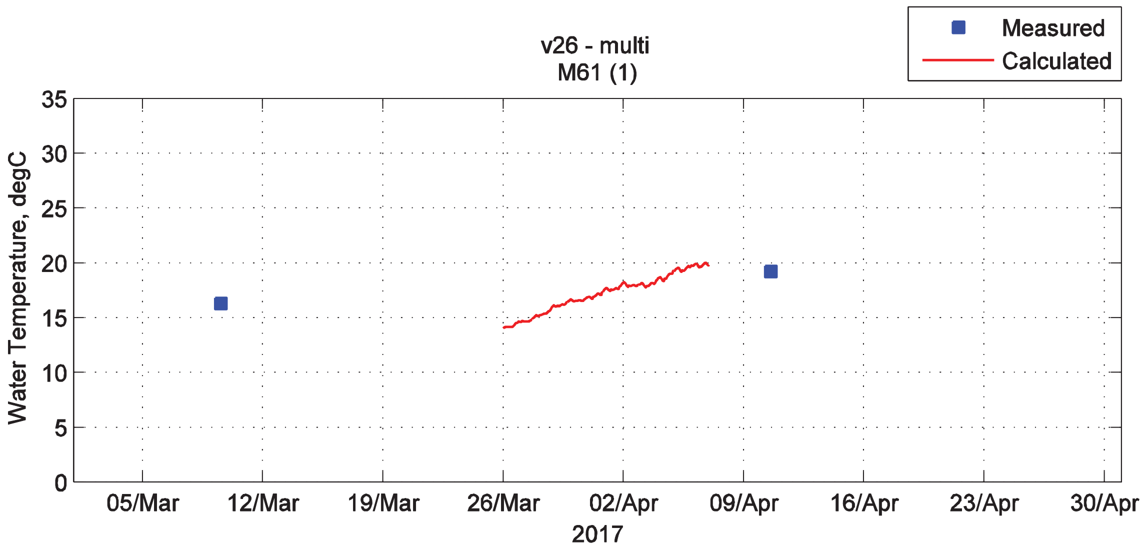

NCF6 (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

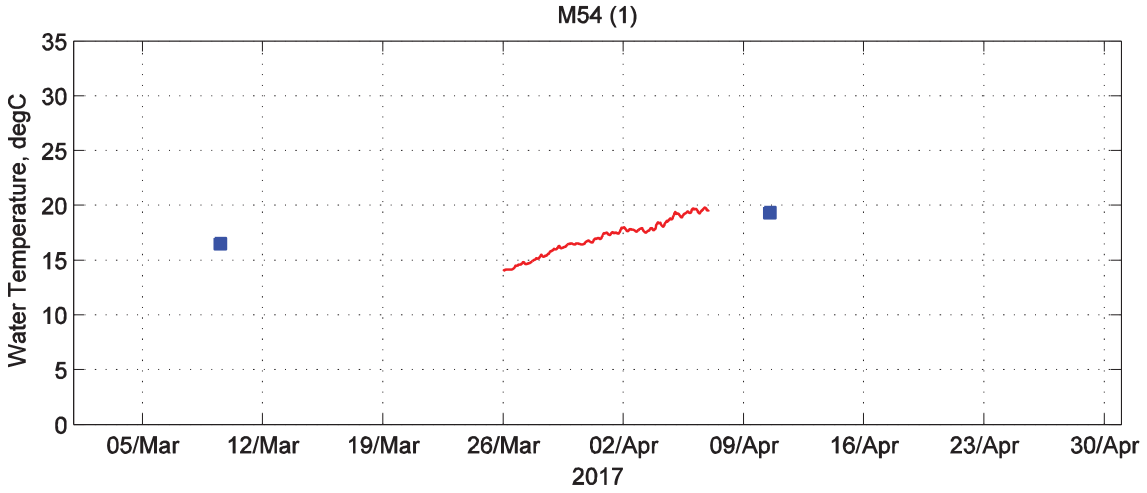

IC (1)
Water Temperature, degC
35
30
25
20
15
10
5
0
05/Mar
12/Mar
19/Mar
26/Mar
02/Apr
09/Apr
16/Apr
23/Apr
30/Apr
2017

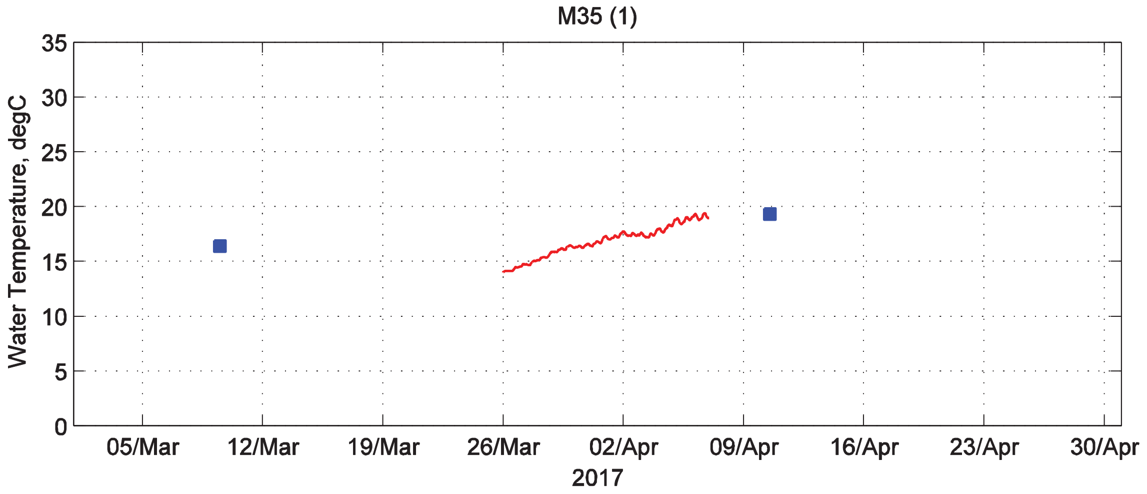

v26 - multi
NAV (1)

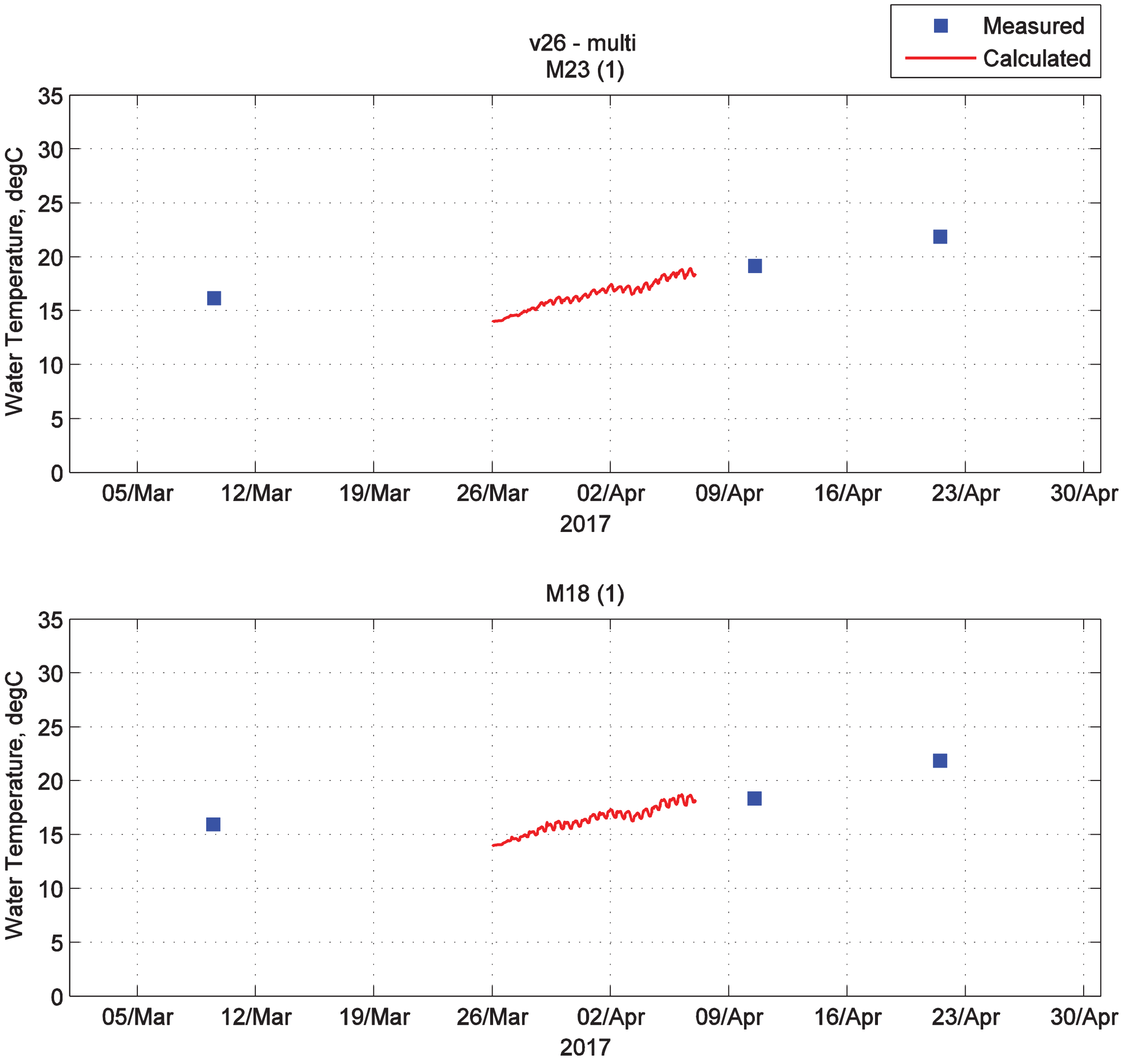

HB (1)


BRR (1)


v26 - multi
M61 (1)


M54 (1)

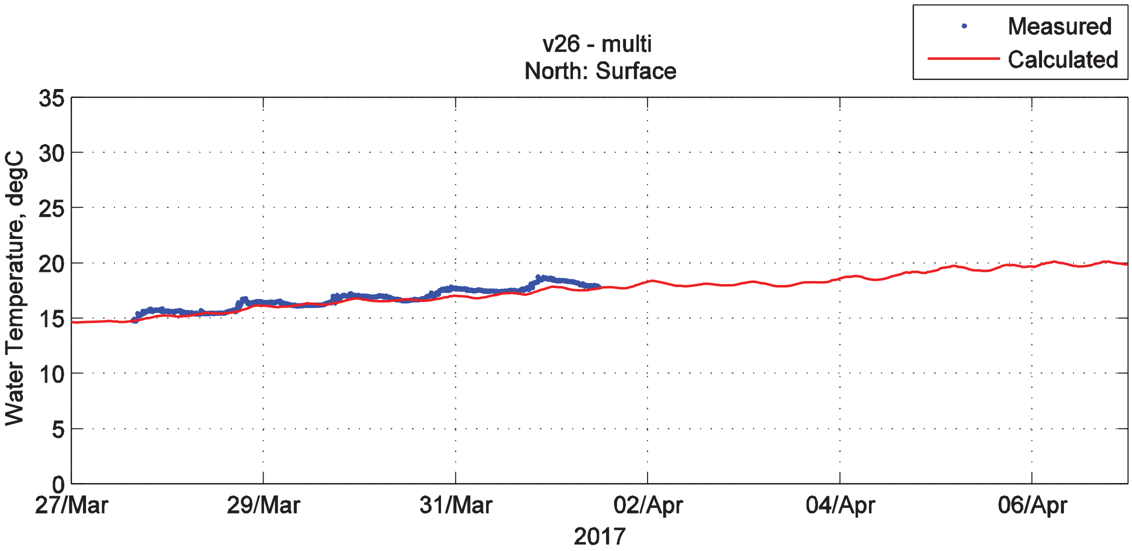

M35 (1)

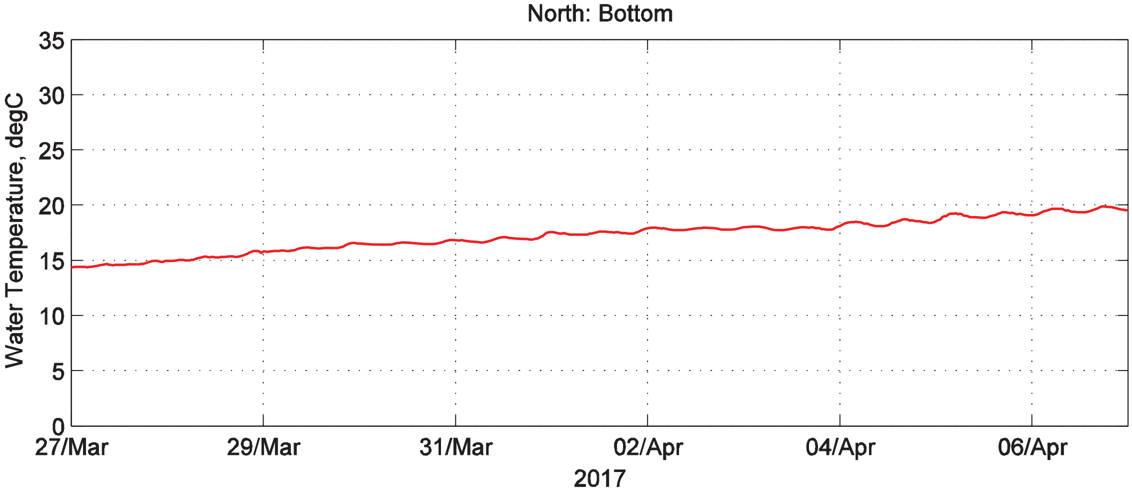


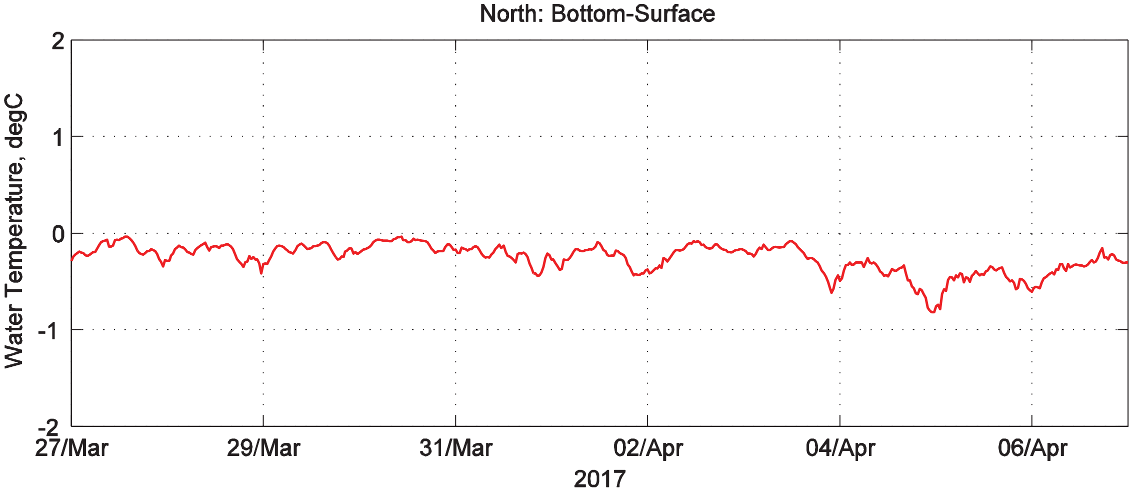
v26 - multi

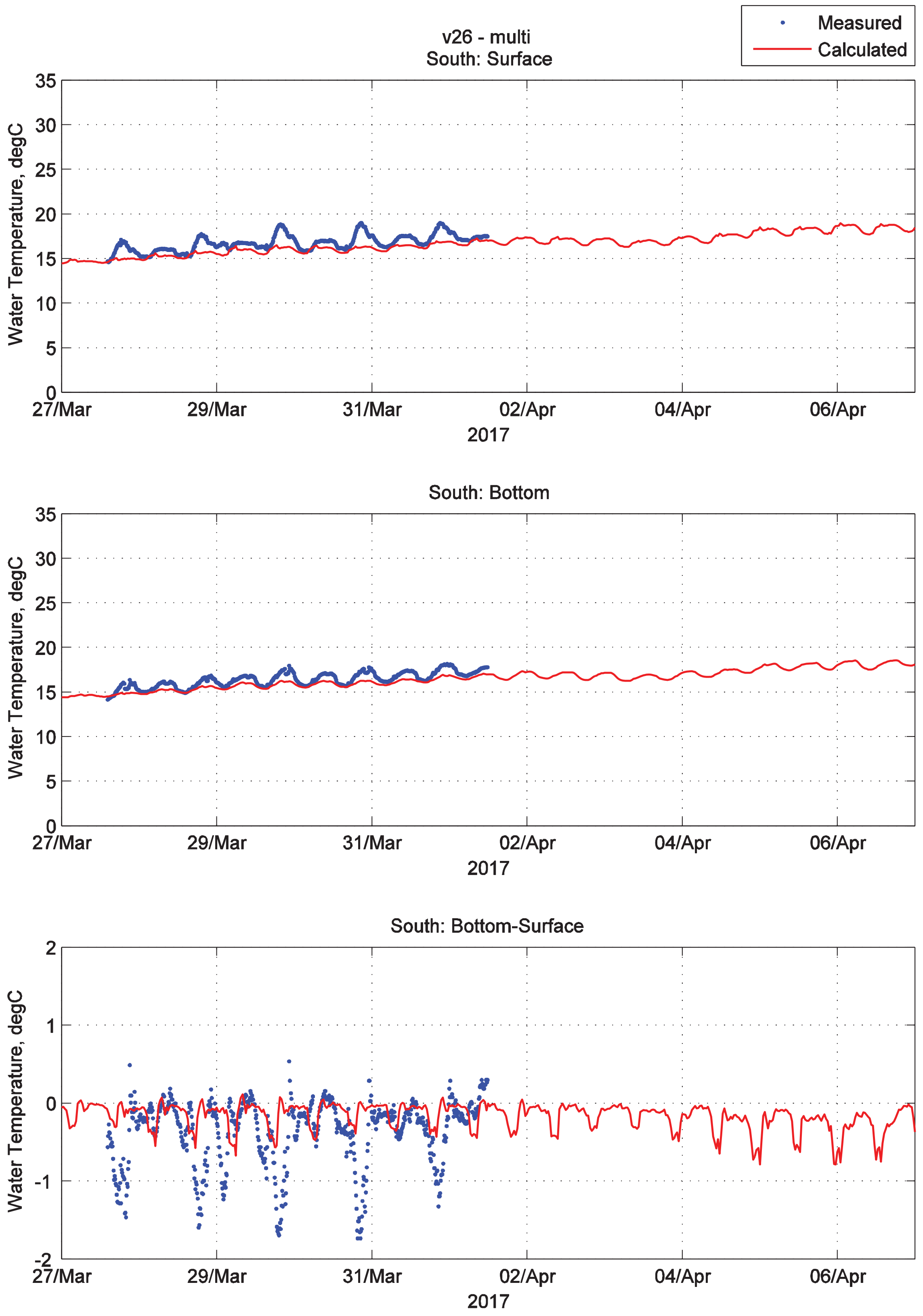
M23 (1)

M18 (1)

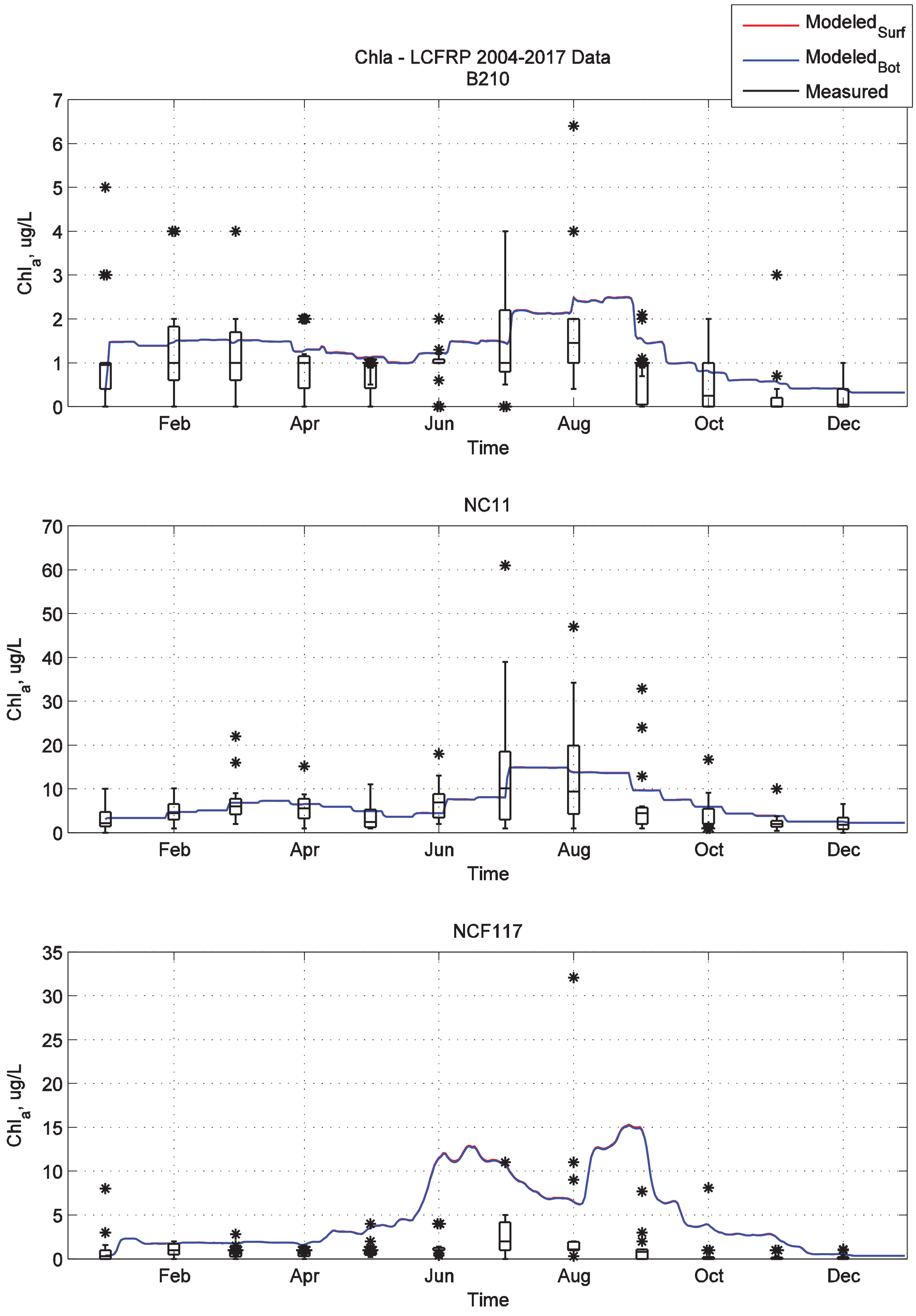

v26 - multi
North: Surface

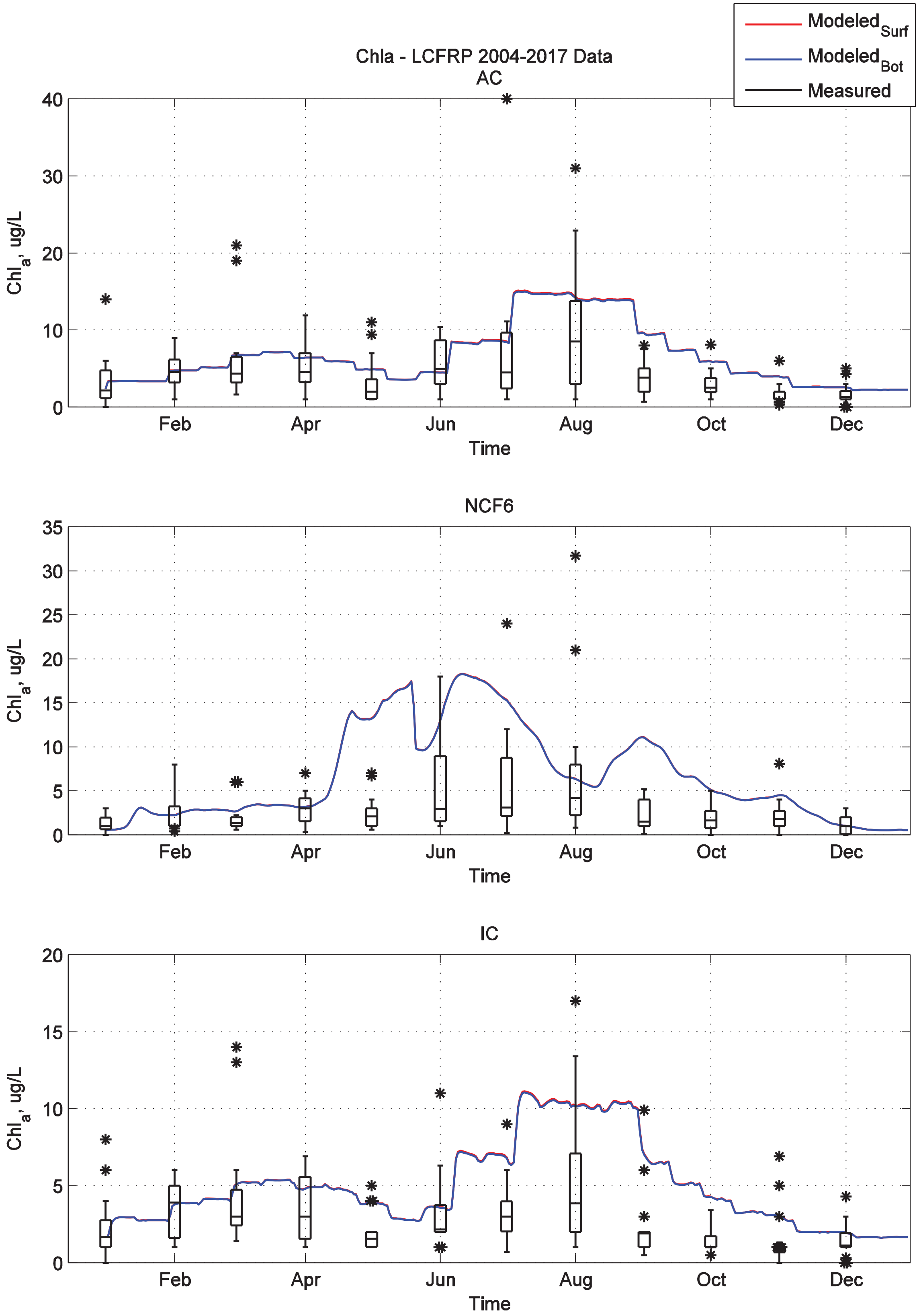

North: Bottom

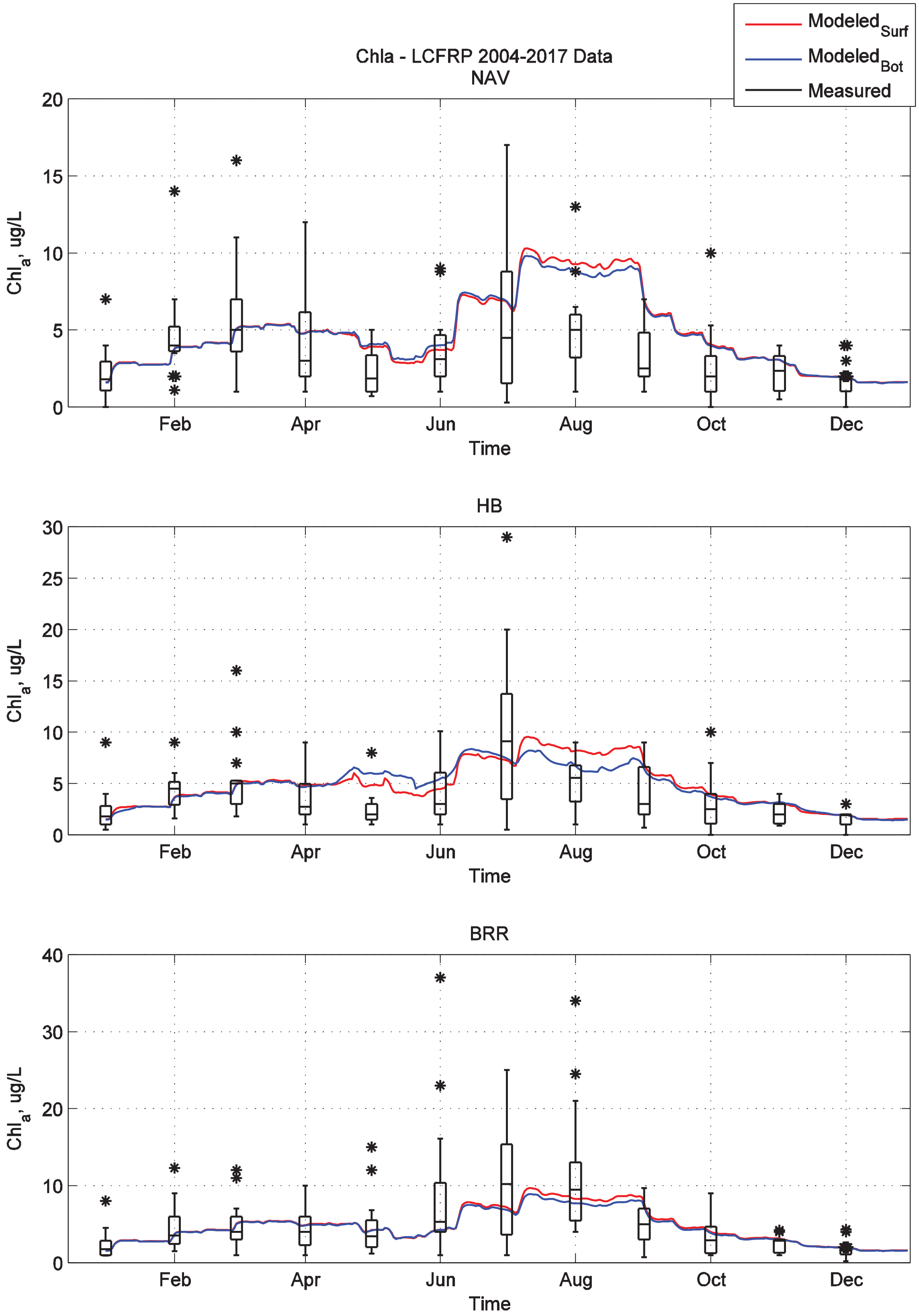

North: Bottom-Surface

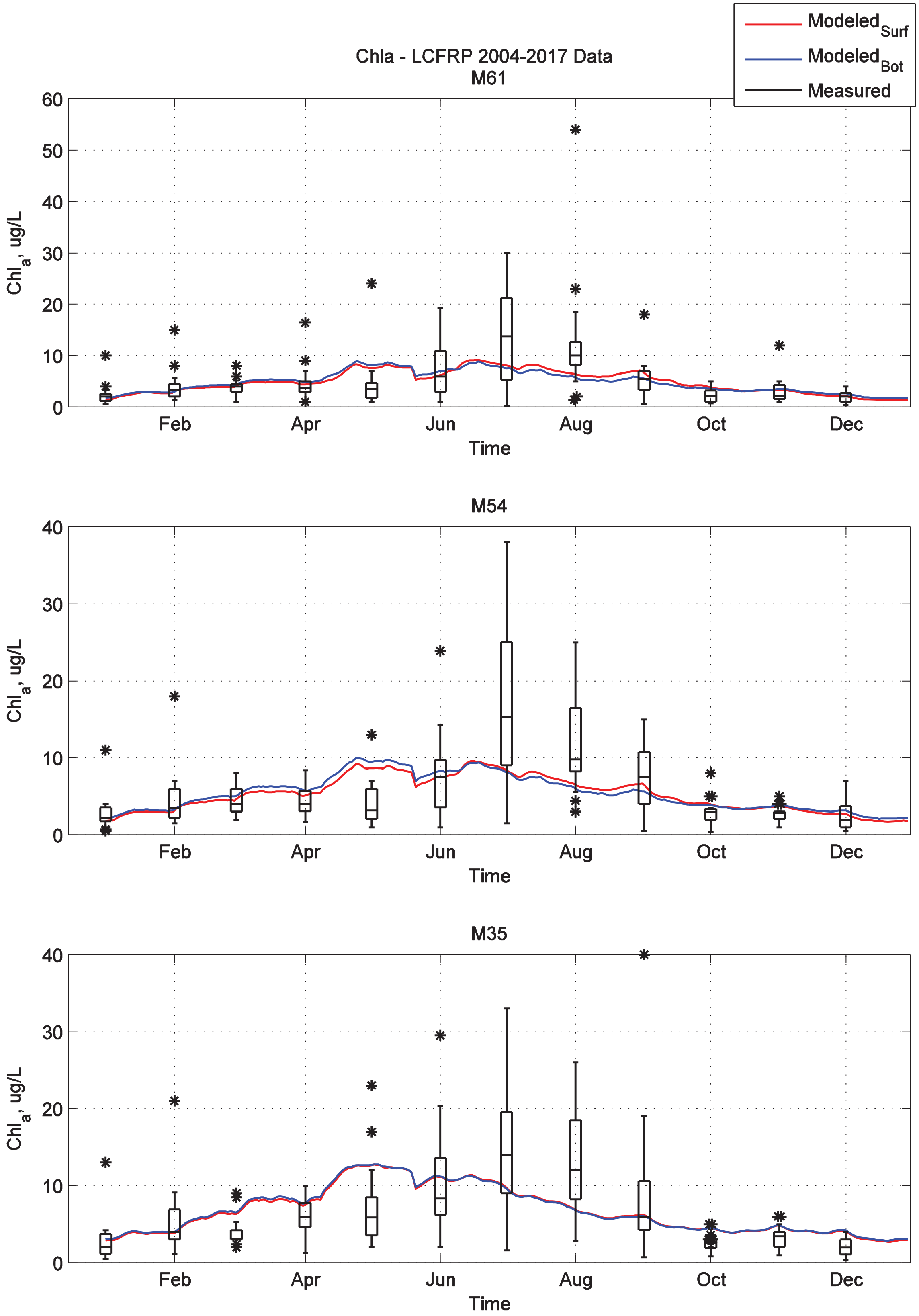

v26 - multi
South: Surface
Measured
Calculated
Water Temperature, degC
35
30
25
20
15
10
5
0
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017
South: Bottom
Water Temperature, degC
35
30
25
20
15
10
5
0
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017
South: Bottom-Surface
Water Temperature, degC
2
1
0
-1
-2
27/Mar
29/Mar
31/Mar
02/Apr
04/Apr
06/Apr
2017

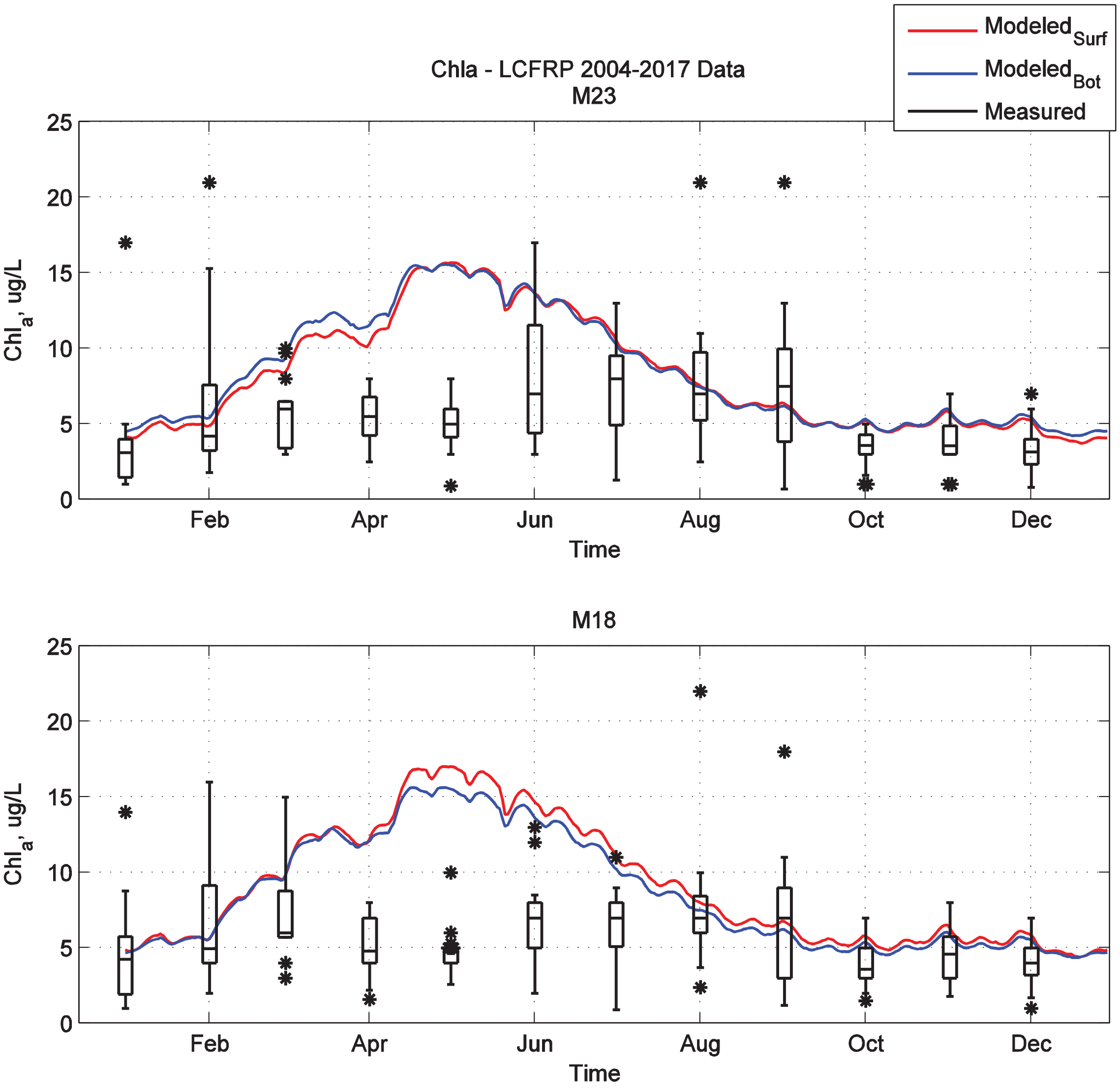
Appendix C–3:
Plots of Modeled & Measured Water Quality Constituents for Typical Year Validation

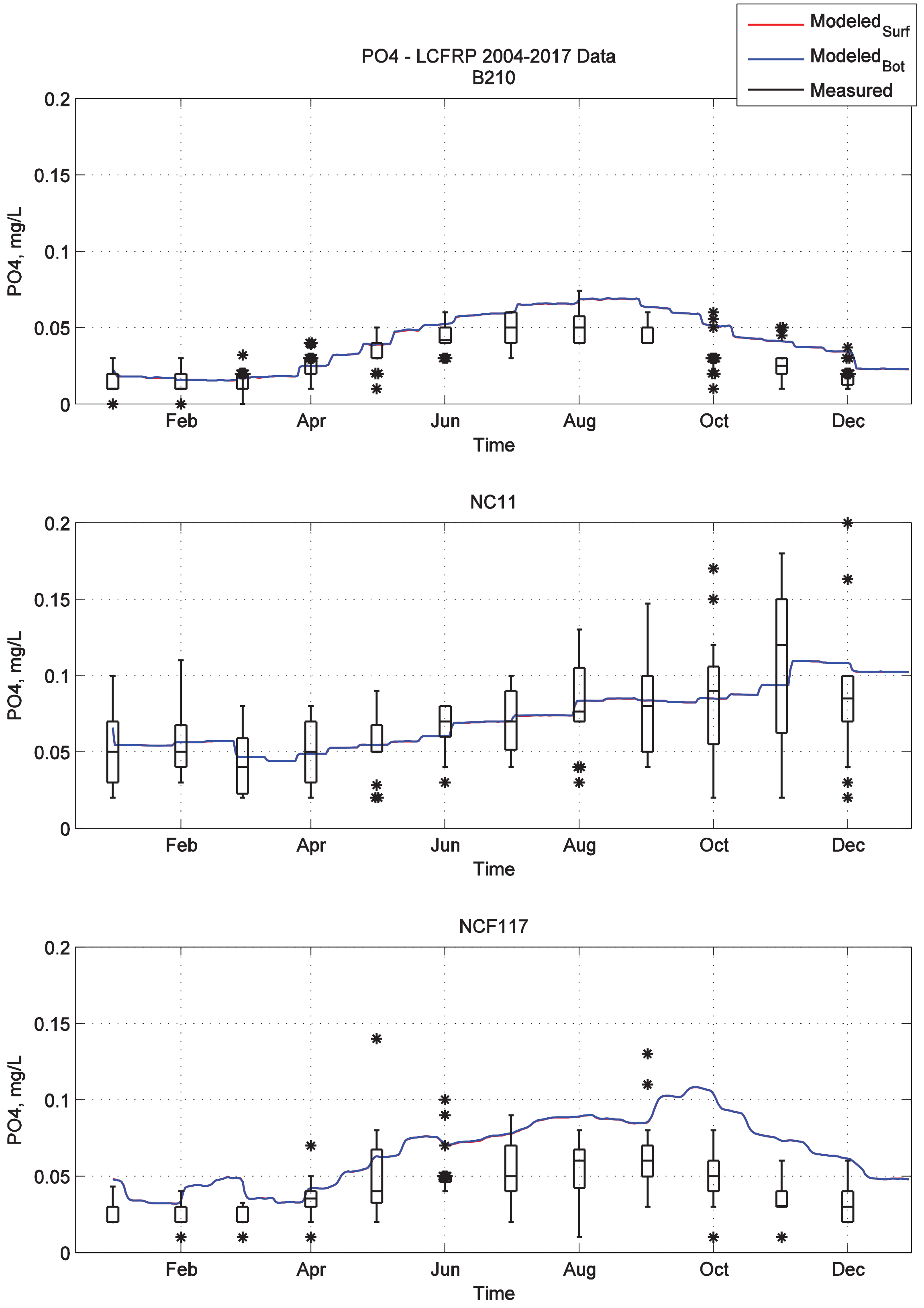

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
Chla - LCFRP 2004-2017 Data
B210
Chl$_a$, ug/L
0
1
2
3
4
5
6
7
Feb
Apr
Jun
Aug
Oct
Dec
Time
NC11
Chl$_a$, ug/L
0
10
20
30
40
50
60
70
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF117
Chl$_a$, ug/L
0
5
10
15
20
25
30
35
Feb
Apr
Jun
Aug
Oct
Dec
Time

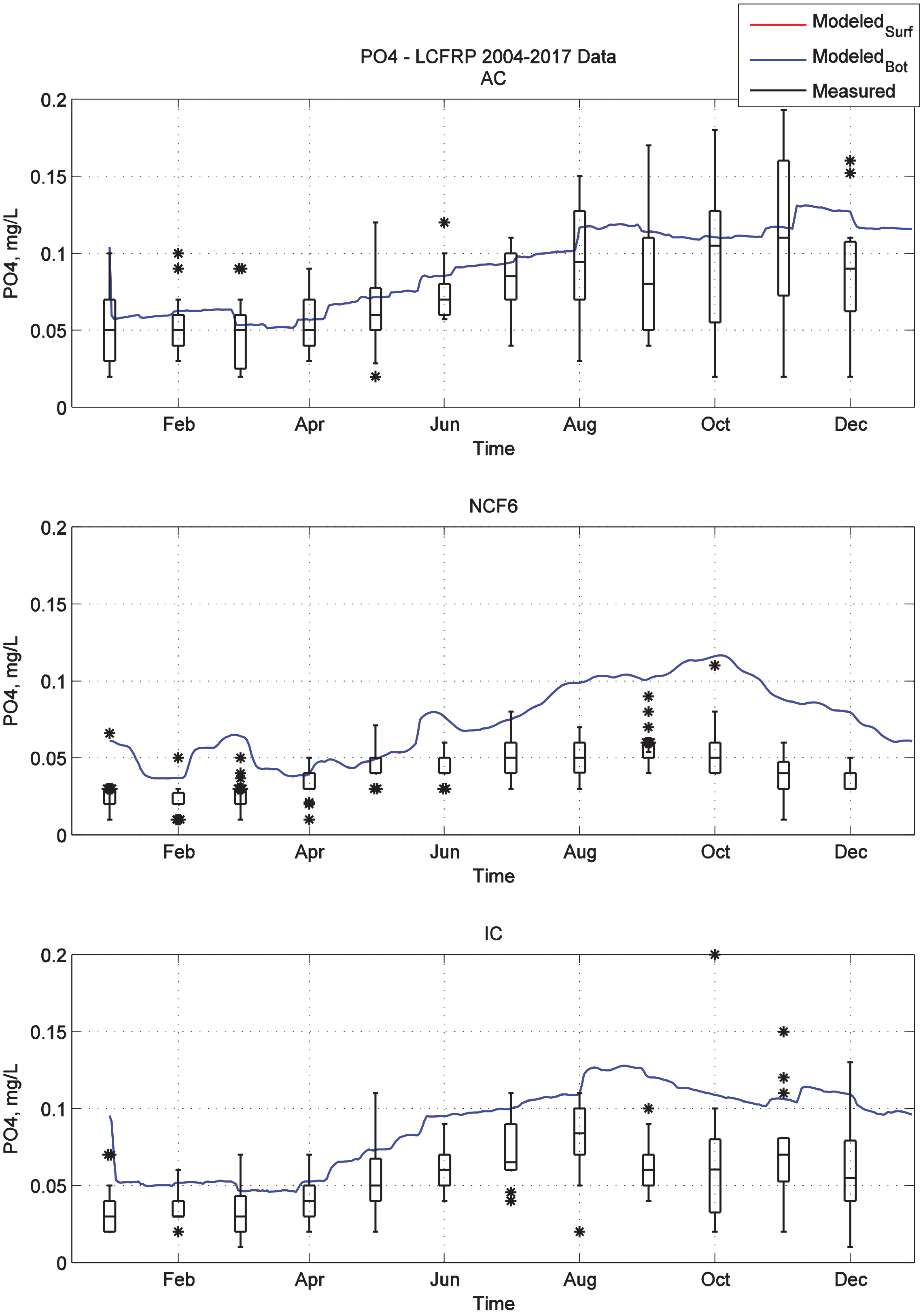

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
Chla - LCFRP 2004-2017 Data
AC
40
30
20
10
0
Chl_a, ug/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF6
35
30
25
20
15
10
5
0
Chl_a, ug/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
IC
20
15
10
5
0
Chl_a, ug/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

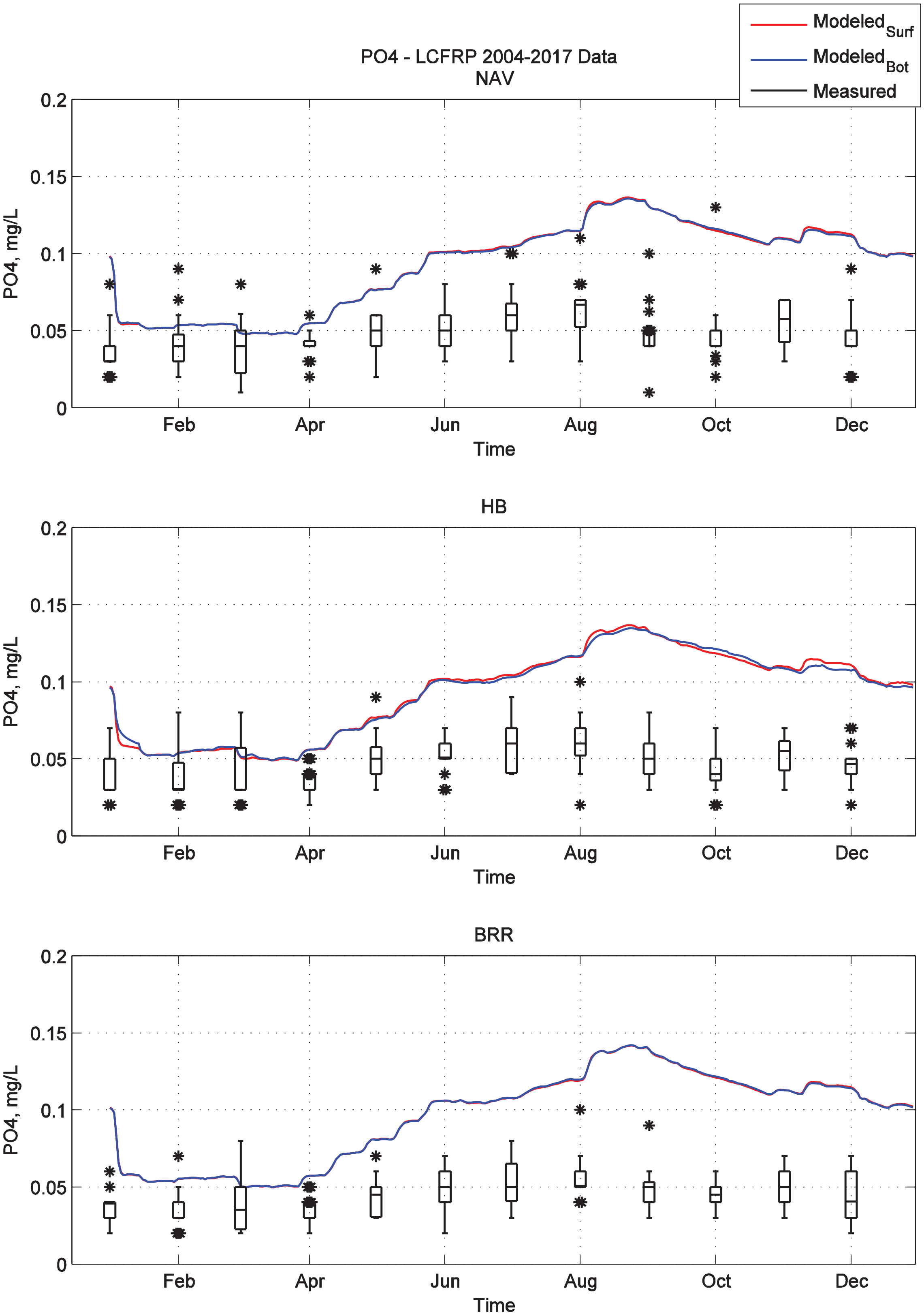

Modeled_Surf
Modeled_Bot
Measured
Chla - LCFRP 2004-2017 Data
NAV
Chl_a, ug/L
20
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
HB
Chl_a, ug/L
30
25
20
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
BRR
Chl_a, ug/L
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

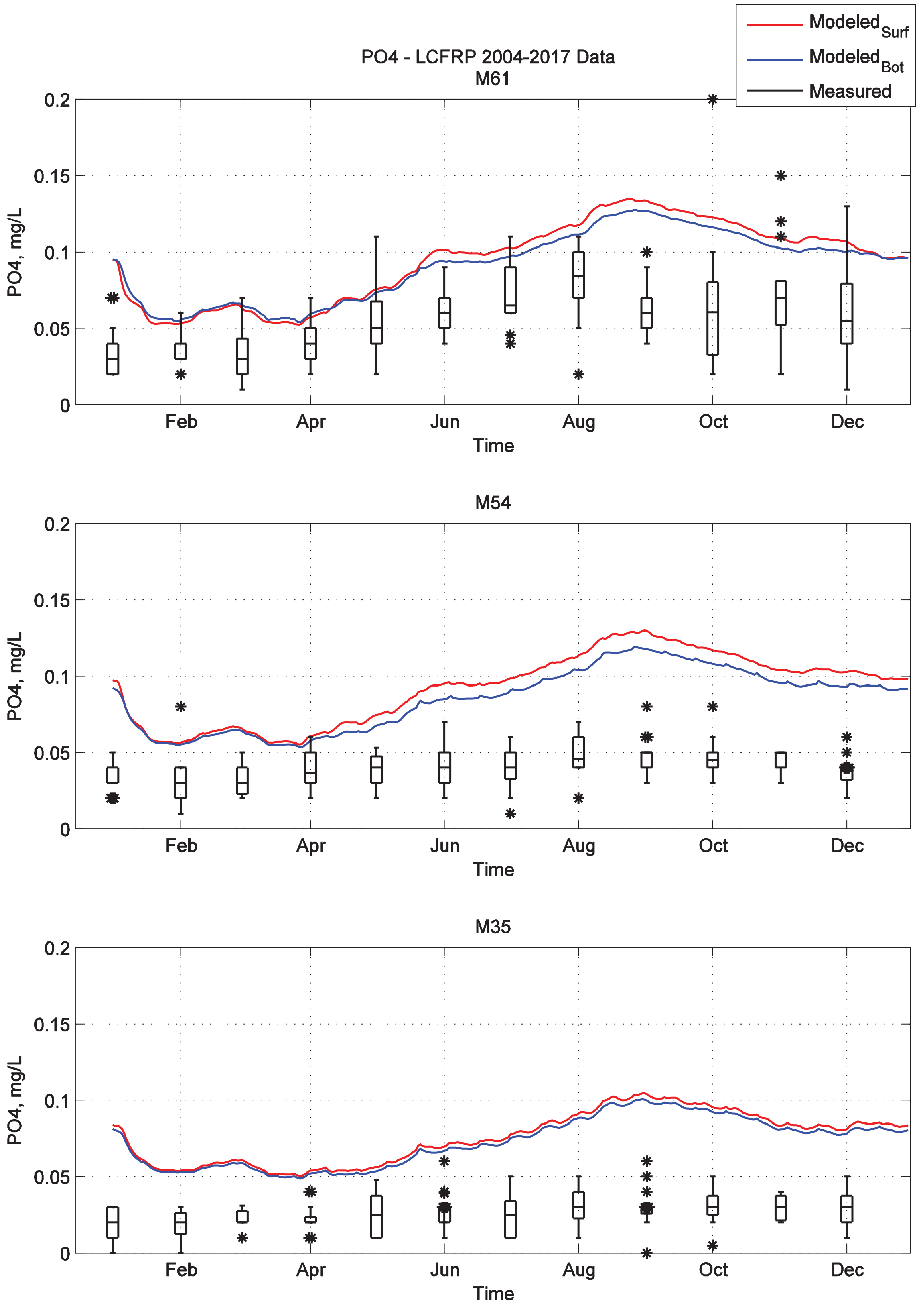

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
Chla - LCFRP 2004-2017 Data
M61
Chl_a, ug/L
0
10
20
30
40
50
60
Feb
Apr
Jun
Aug
Oct
Dec
Time
M54
Chl_a, ug/L
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
M35
Chl_a, ug/L
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

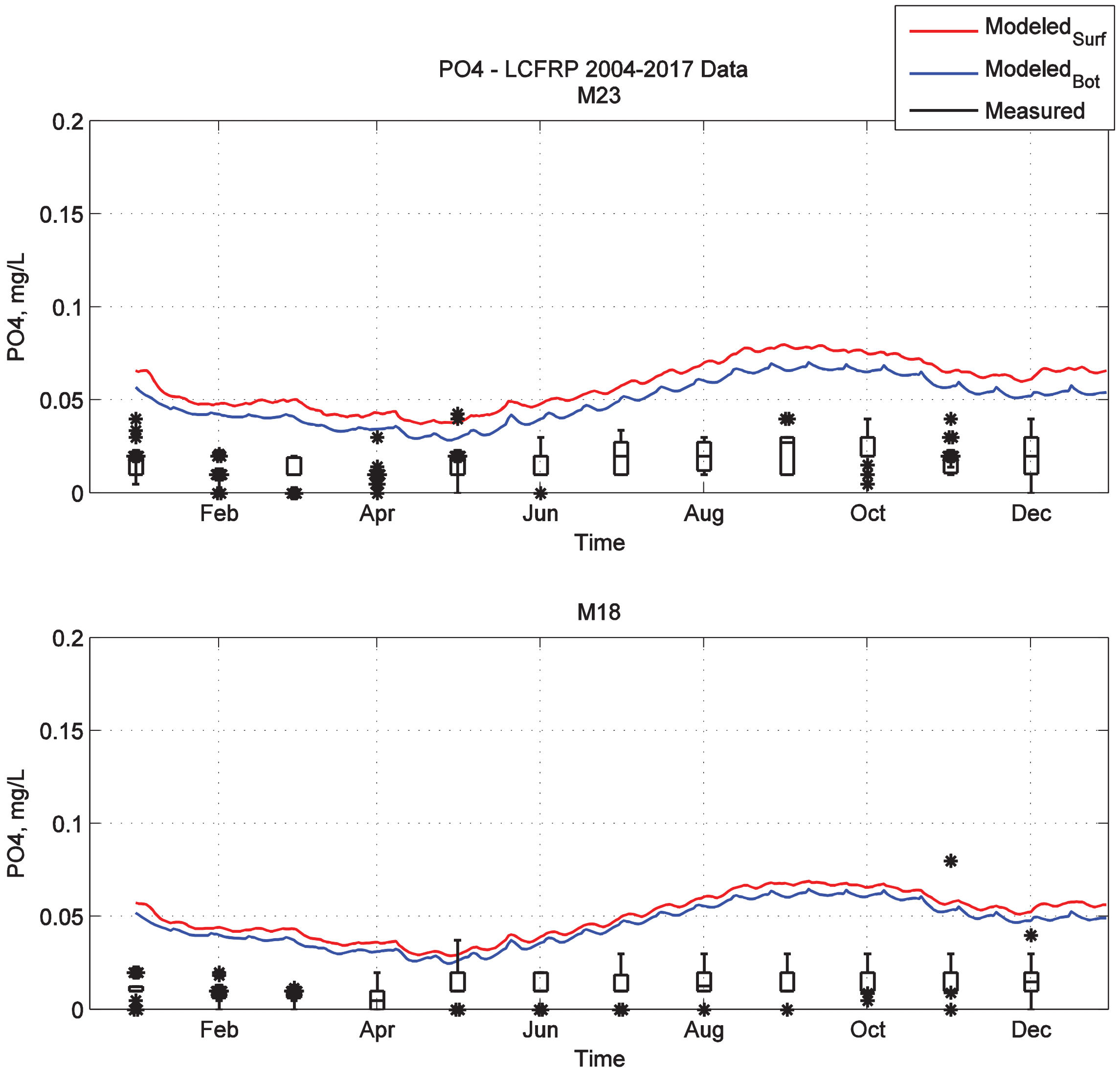

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
Chla - LCFRP 2004-2017 Data
M23
Chl$_a$, ug/L
0
5
10
15
20
25
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
Chl$_a$, ug/L
0
5
10
15
20
25
Feb
Apr
Jun
Aug
Oct
Dec
Time

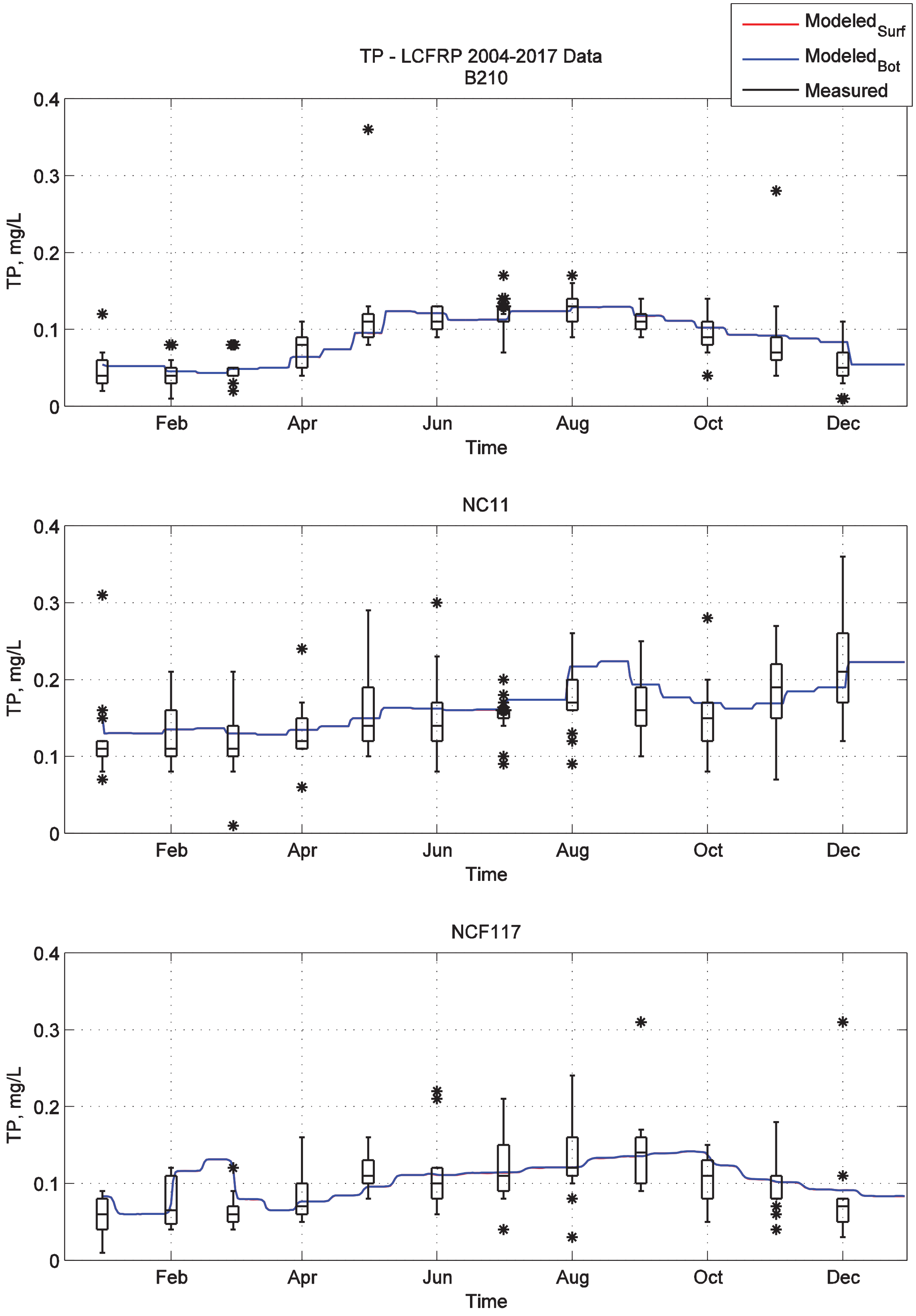

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
PO4 - LCFRP 2004-2017 Data
B210
NC11
NCF117
PO4, mg/L
0
0.05
0.1
0.15
0.2
Feb
Apr
Jun
Aug
Oct
Dec
Time

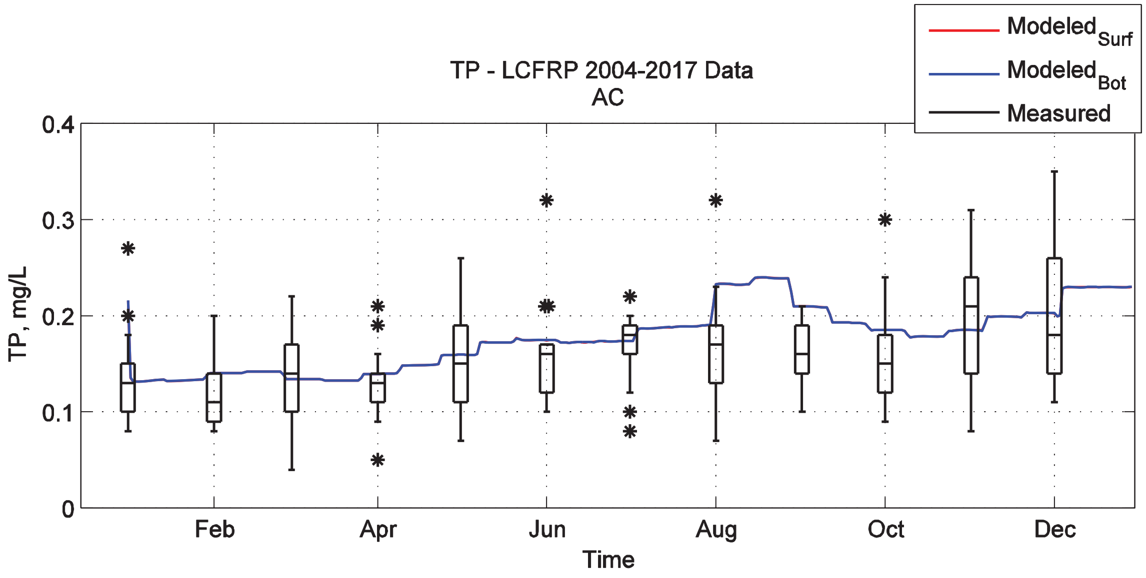

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
PO4 - LCFRP 2004-2017 Data
AC
NCF6
IC
PO4, mg/L
0
0.05
0.1
0.15
0.2
Feb
Apr
Jun
Aug
Oct
Dec
Time

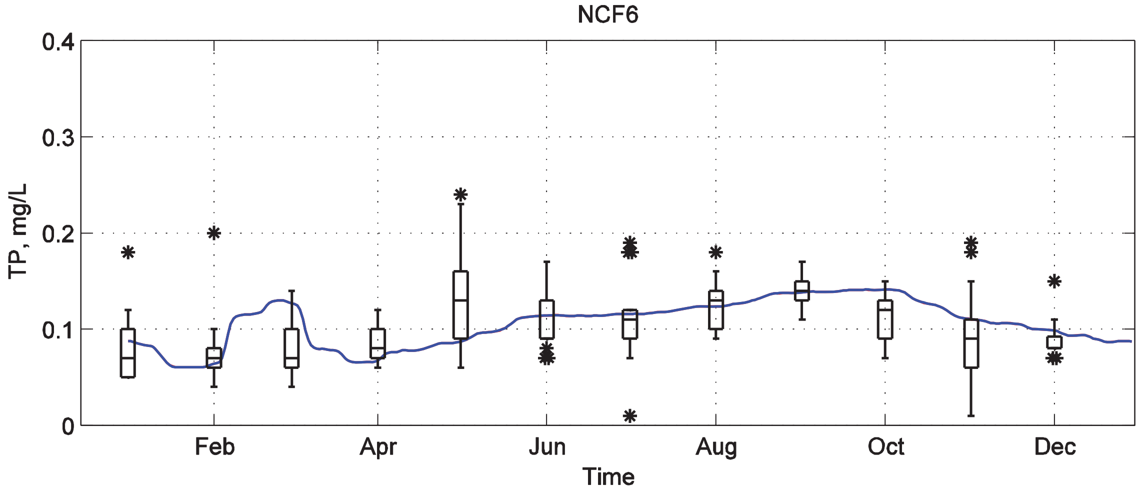

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
PO4 - LCFRP 2004-2017 Data
NAV
HB
BRR
PO4, mg/L
Time
0
0.05
0.1
0.15
0.2
Feb
Apr
Jun
Aug
Oct
Dec

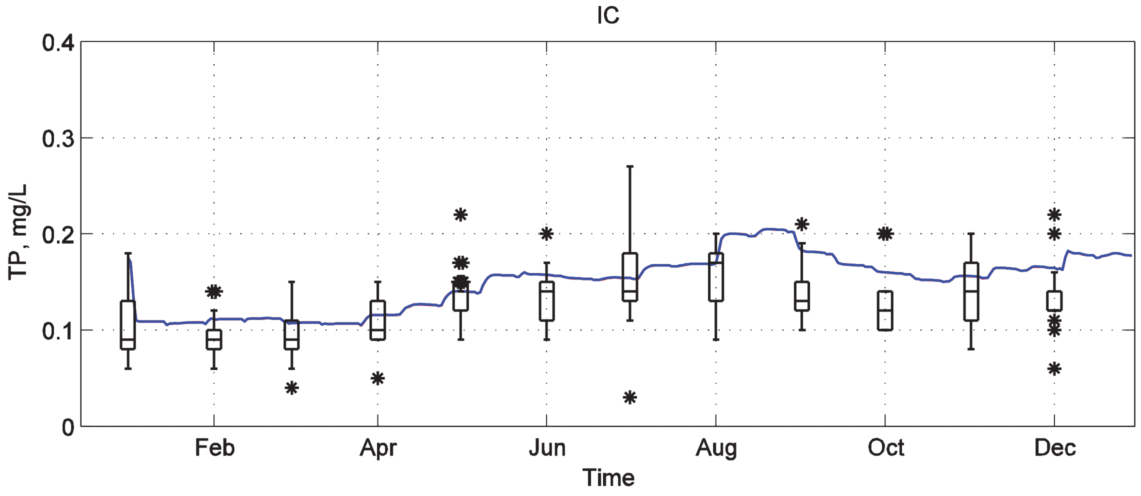

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
PO4 - LCFRP 2004-2017 Data
M61
PO4, mg/L
0.2
0.15
0.1
0.05
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M54
M35

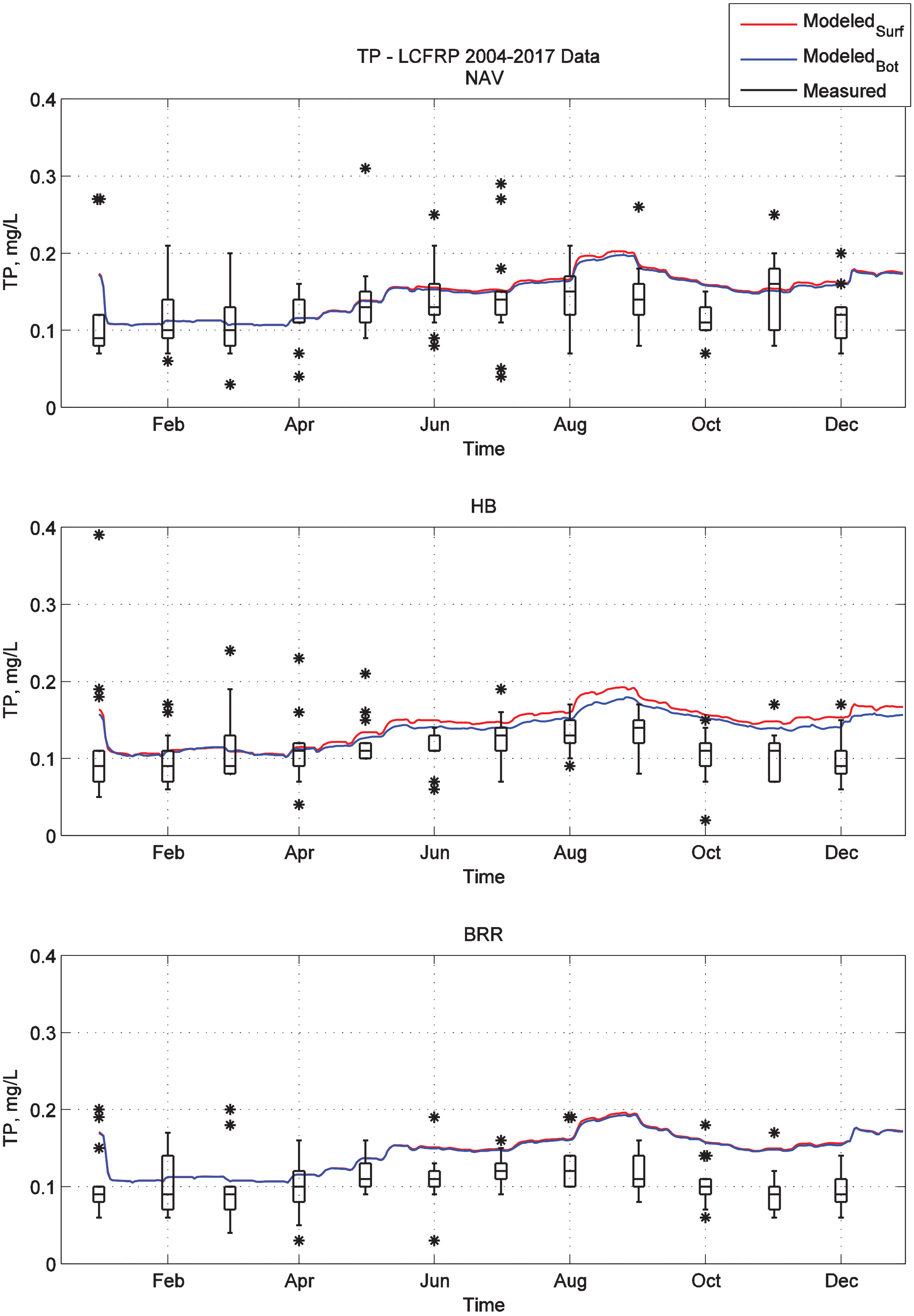

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
PO4 - LCFRP 2004-2017 Data
M23
0.2
0.15
0.1
0.05
0
PO4, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
0.2
0.15
0.1
0.05
0
PO4, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

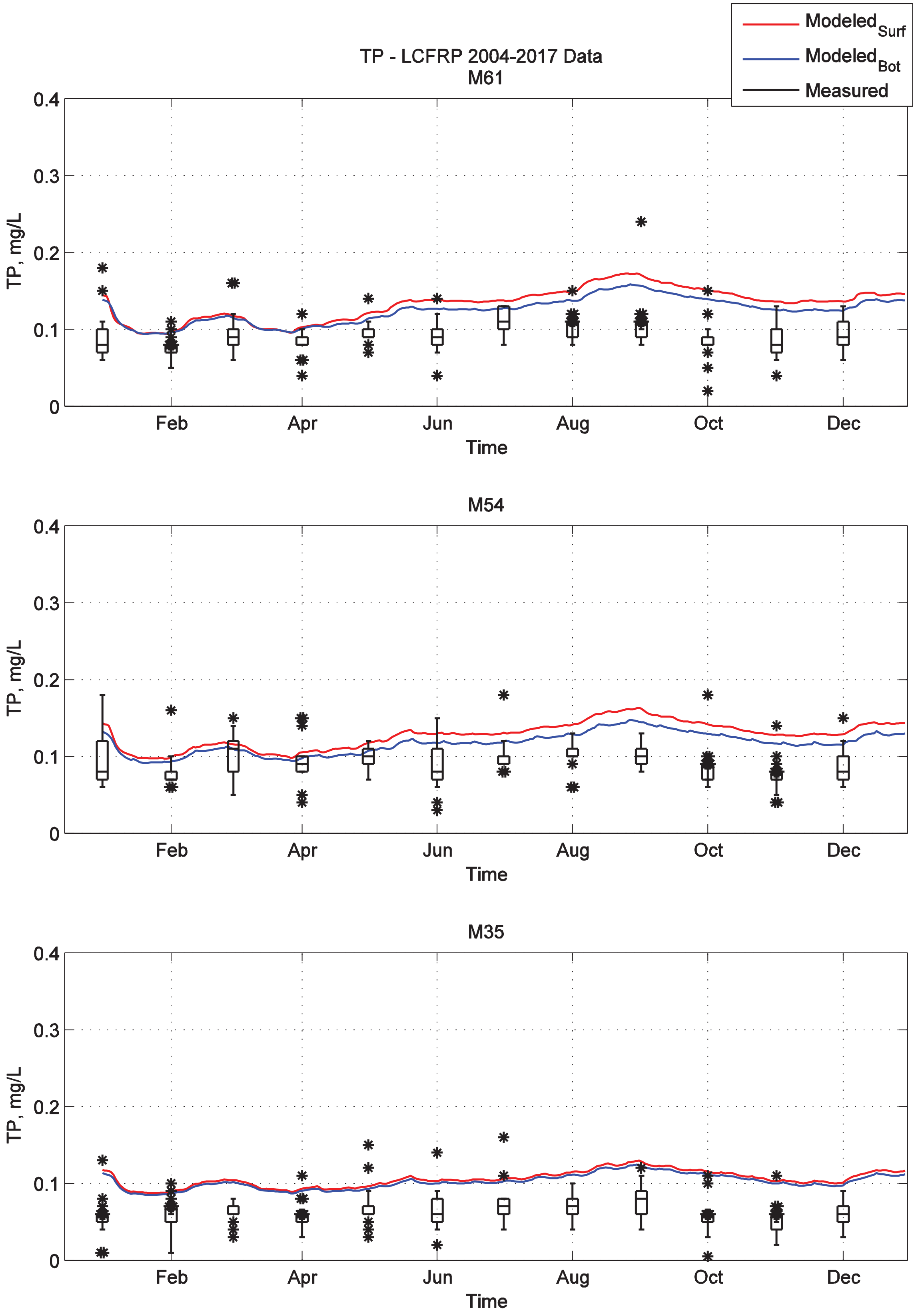

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TP - LCFRP 2004-2017 Data
B210
NC11
NCF117
TP, mg/L
0
0.1
0.2
0.3
0.4
Feb
Apr
Jun
Aug
Oct
Dec
Time

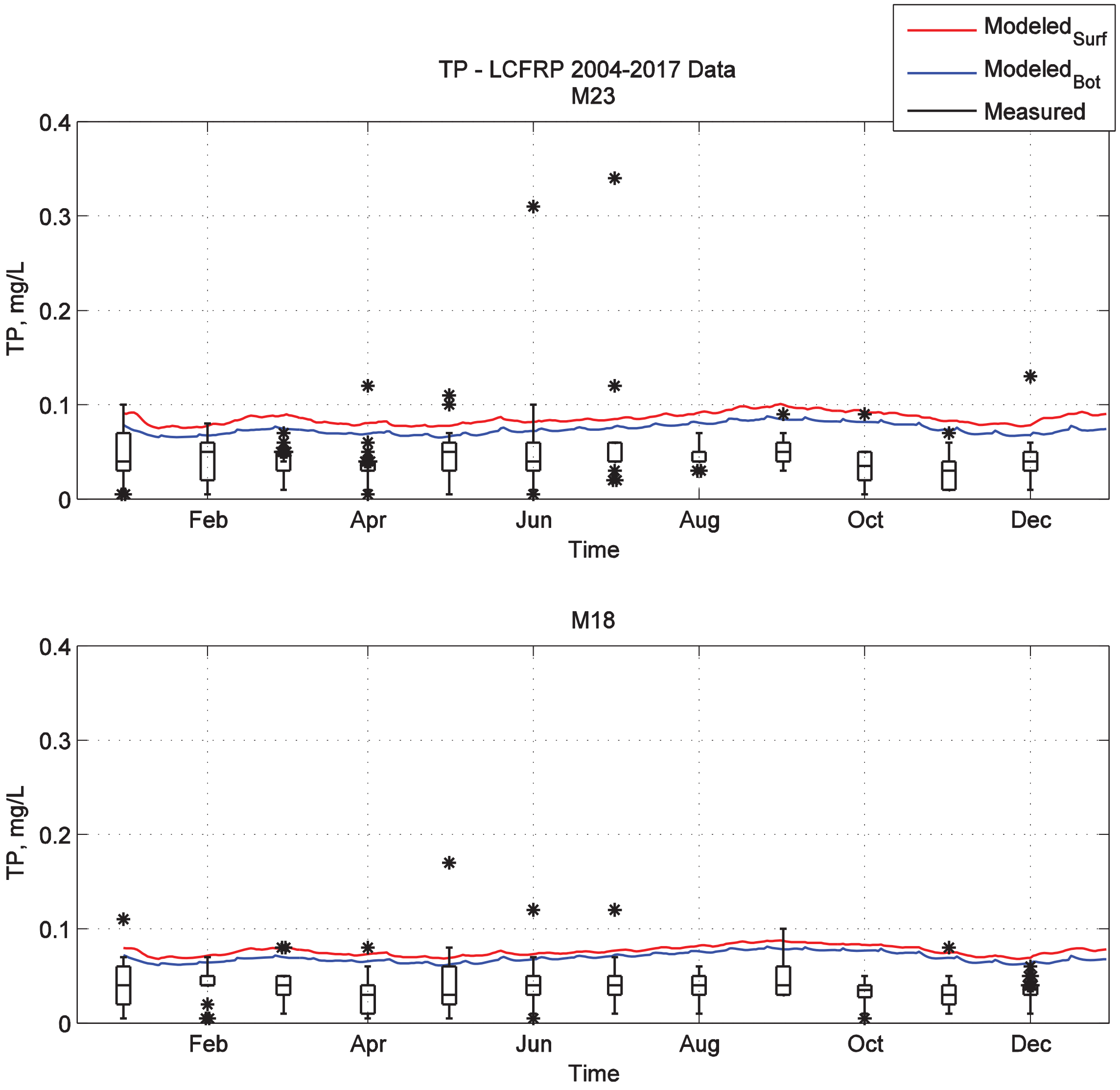

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TP - LCFRP 2004-2017 Data
AC
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

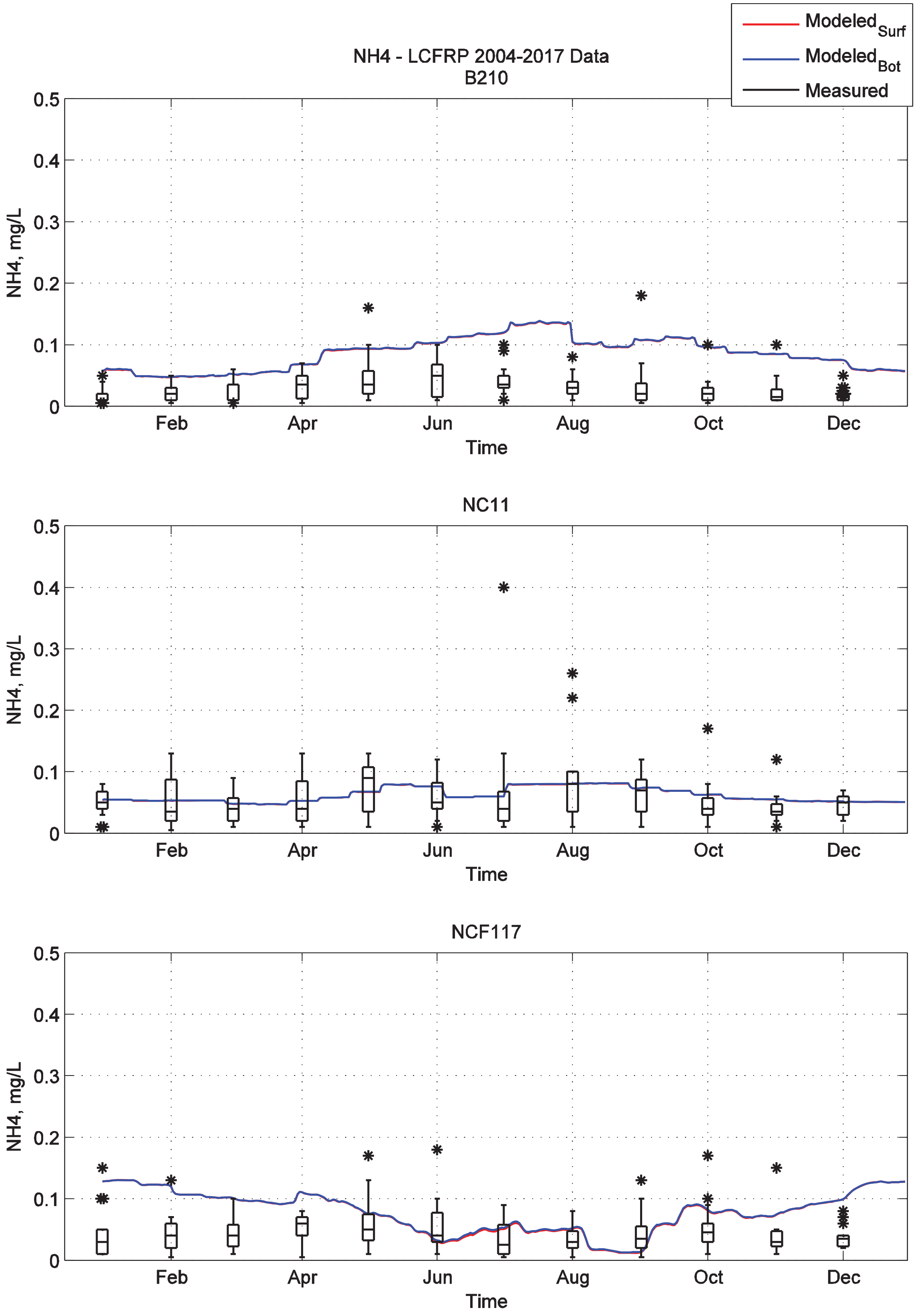

NCF6
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

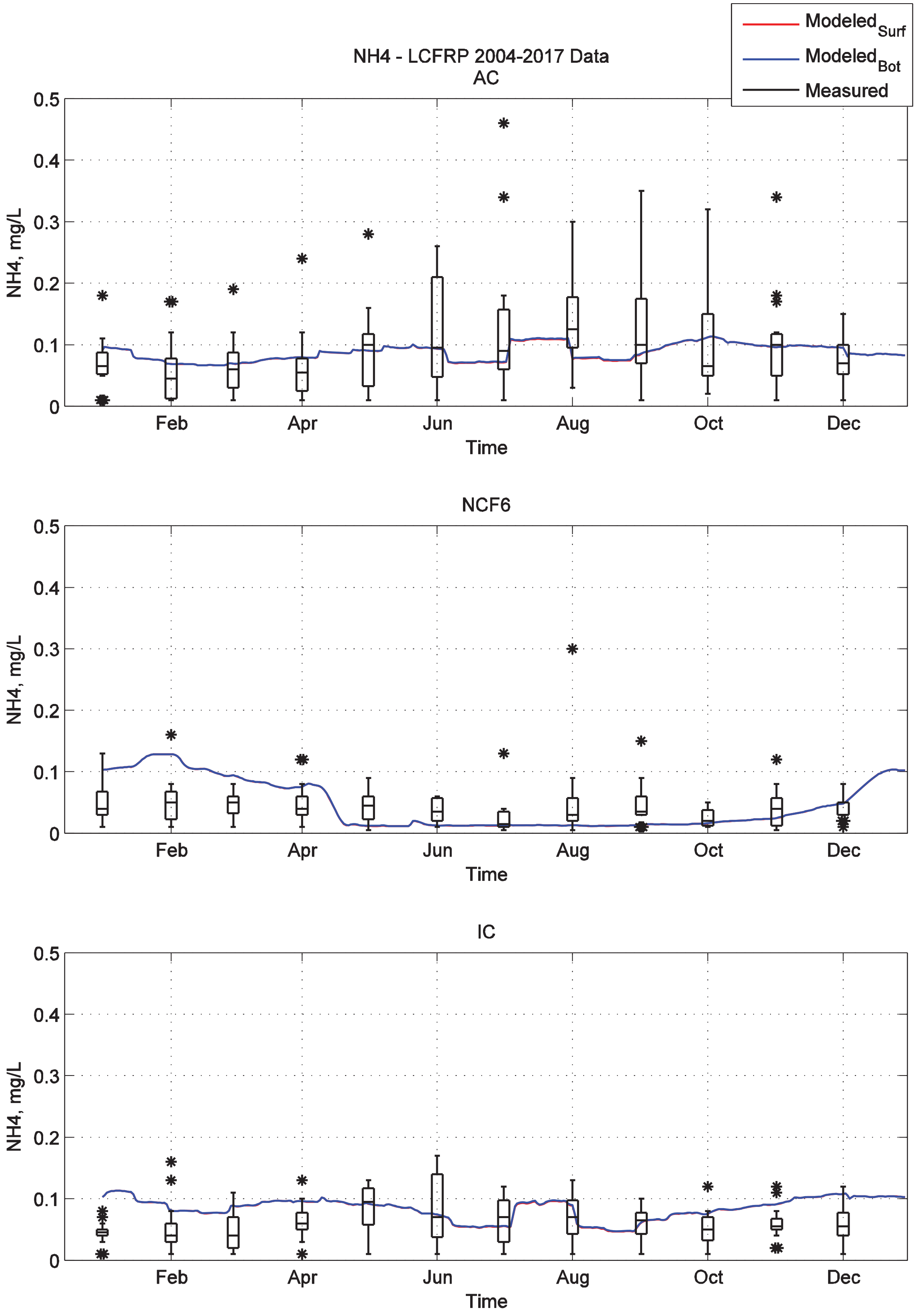

IC
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

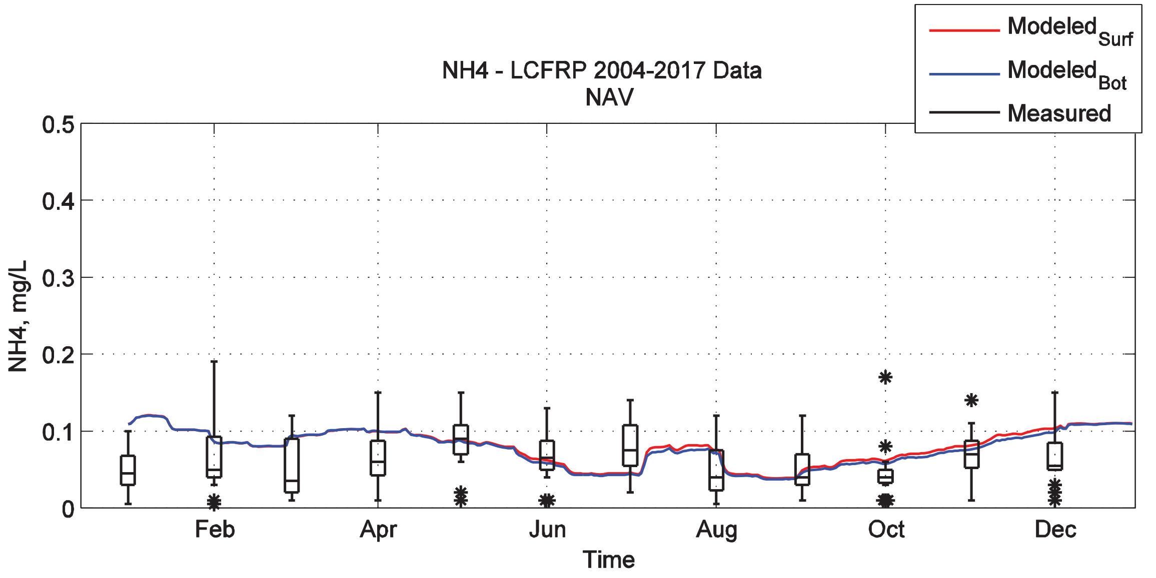

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TP - LCFRP 2004-2017 Data
NAV
HB
BRR
TP, mg/L
0
0.1
0.2
0.3
0.4
Feb
Apr
Jun
Aug
Oct
Dec
Time

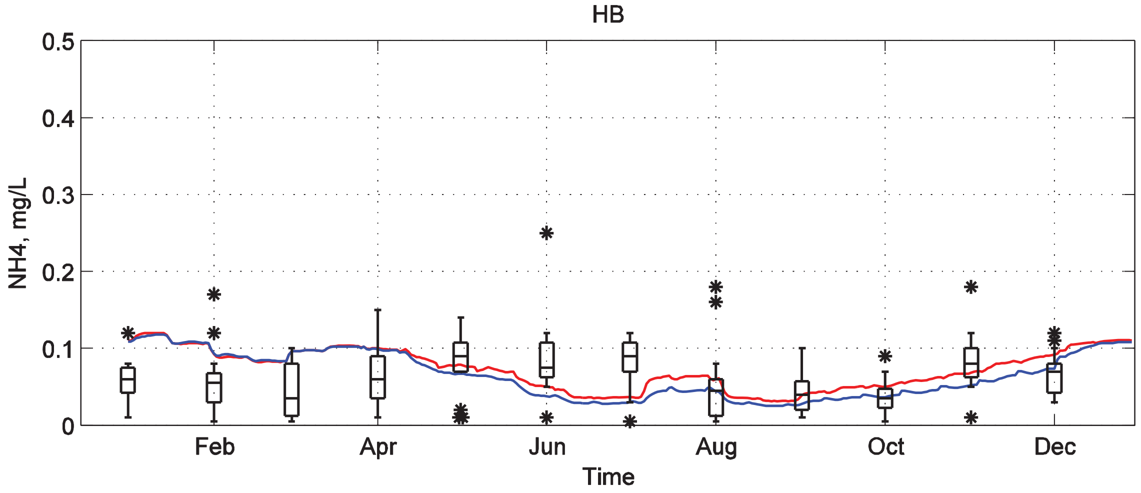

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TP - LCFRP 2004-2017 Data
M61
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M54
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M35
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

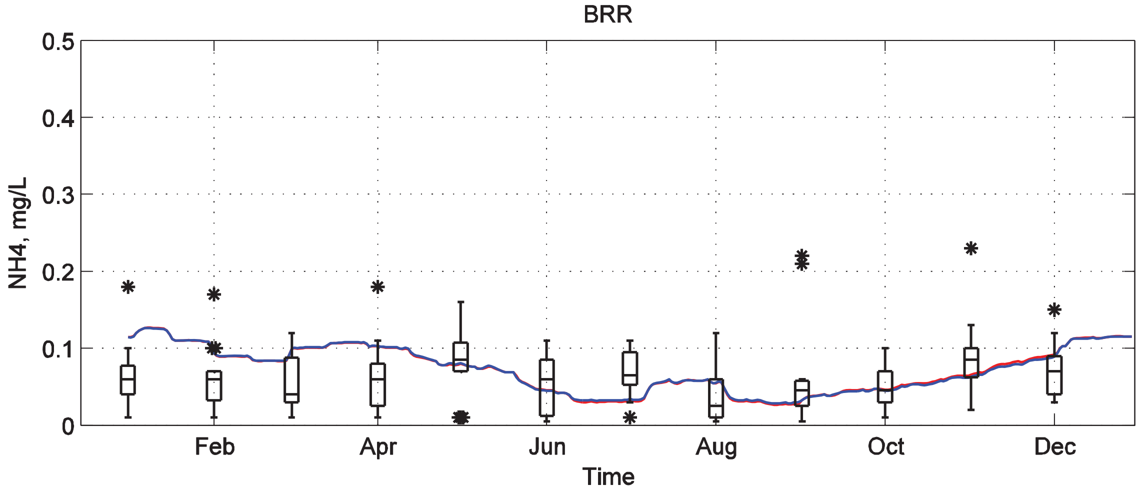

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TP - LCFRP 2004-2017 Data
M23
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
TP, mg/L
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

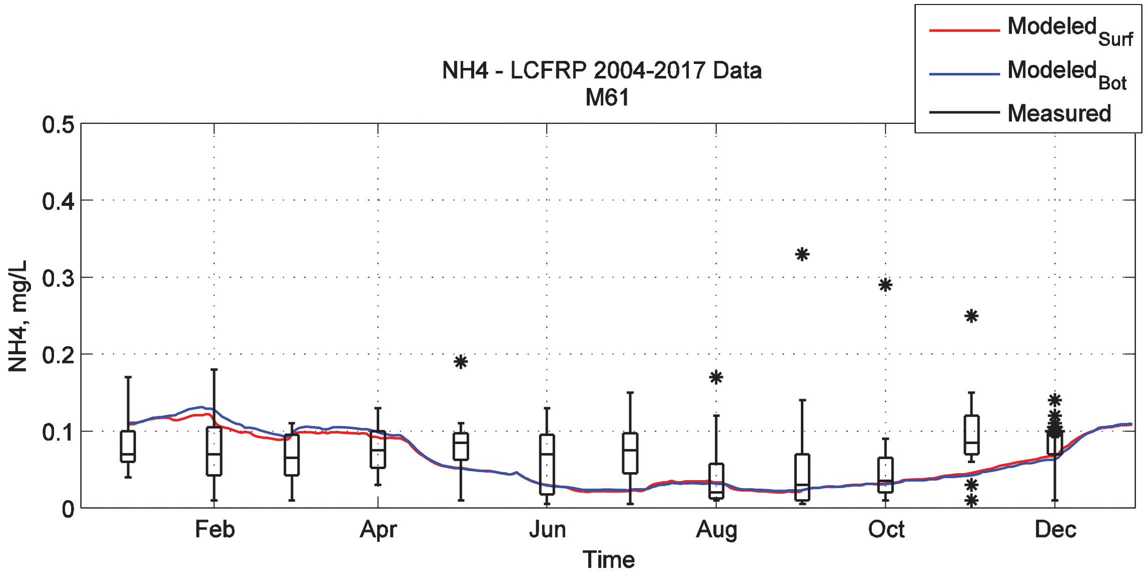

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NH4 - LCFRP 2004-2017 Data
B210
NC11
NCF117
NH4, mg/L
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec
Time

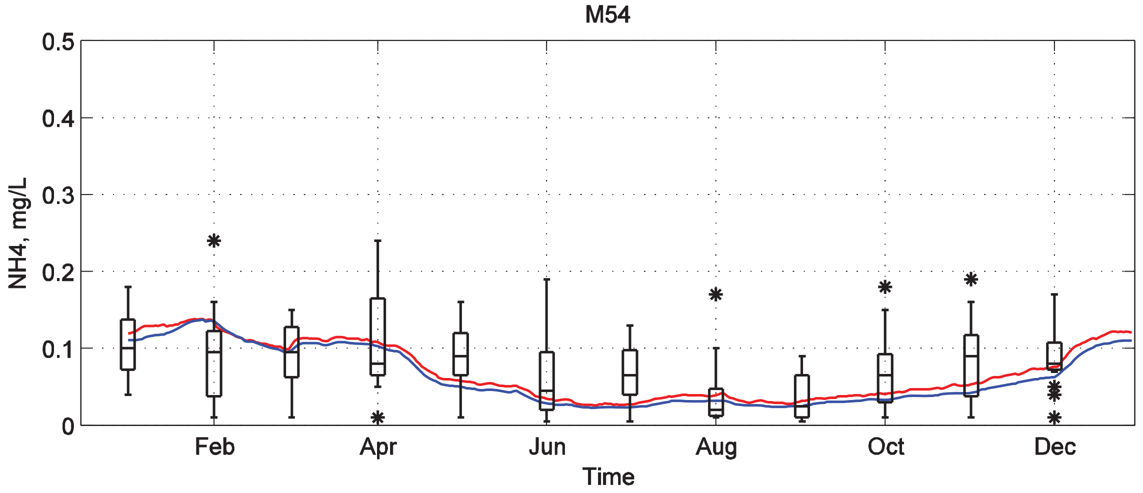

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NH4 - LCFRP 2004-2017 Data
AC
NH4, mg/L
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF6
NH4, mg/L
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec
Time
IC
NH4, mg/L
0
0.1
0.2
0.3
0.4
0.5
Feb
Apr
Jun
Aug
Oct
Dec
Time

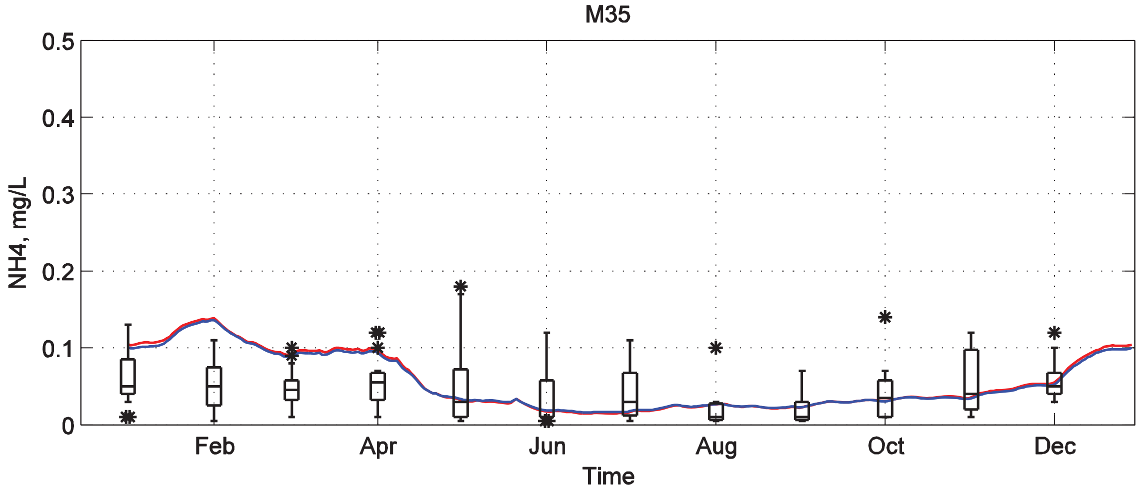

NH4 - LCFRP 2004-2017 Data
NAV
Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

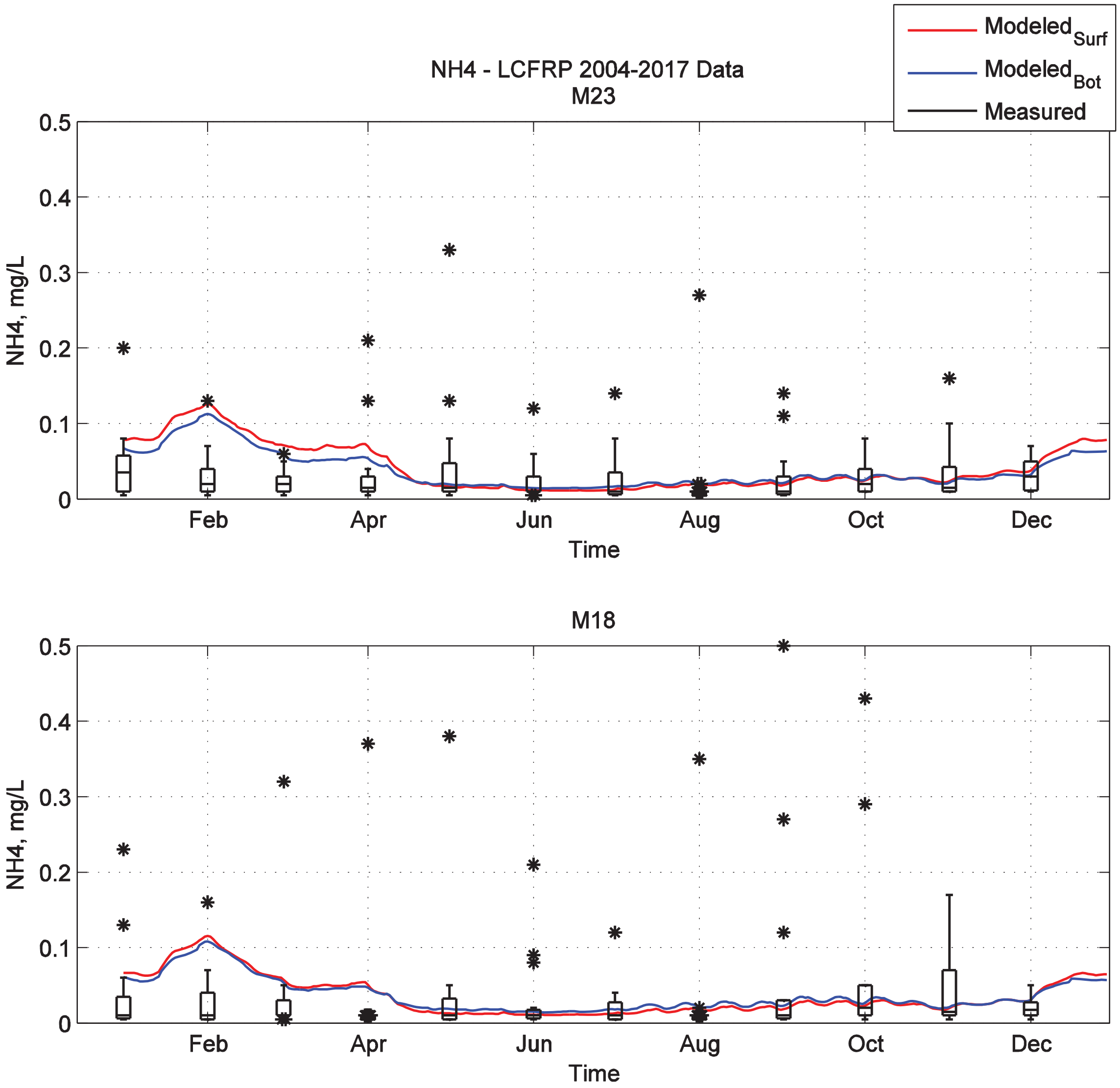

HB
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

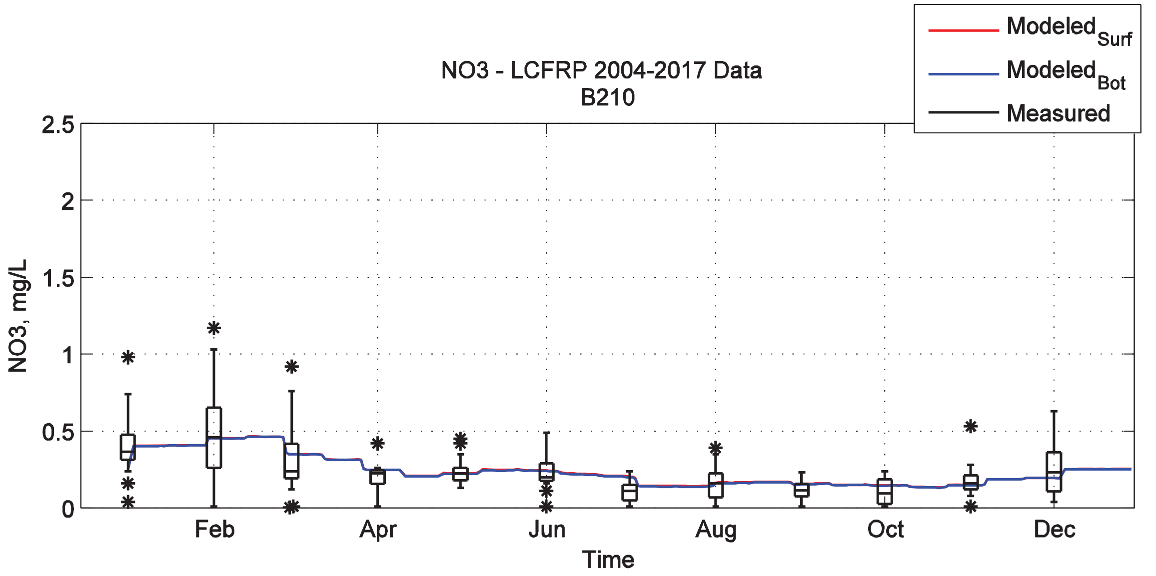

BRR
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

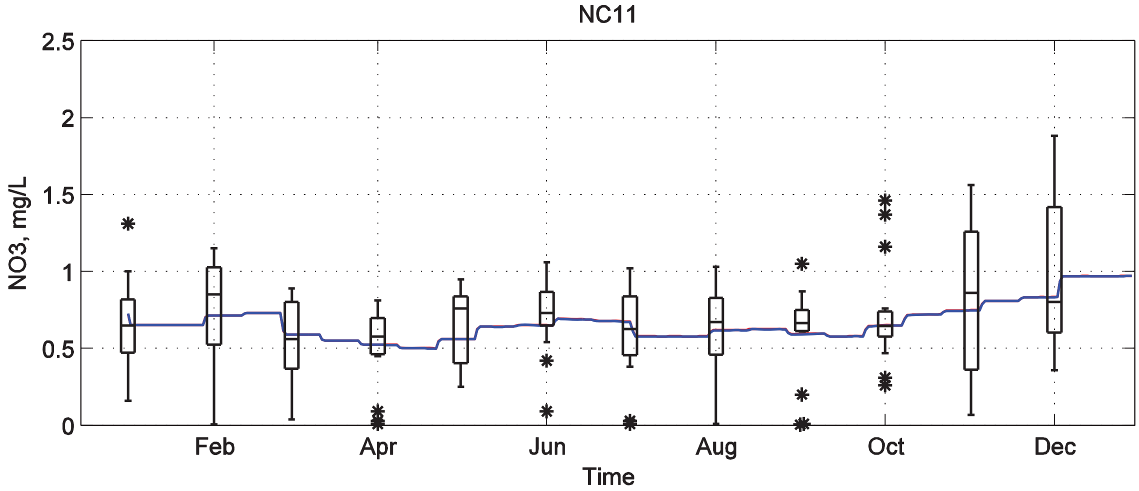

NH4 - LCFRP 2004-2017 Data
M61
Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

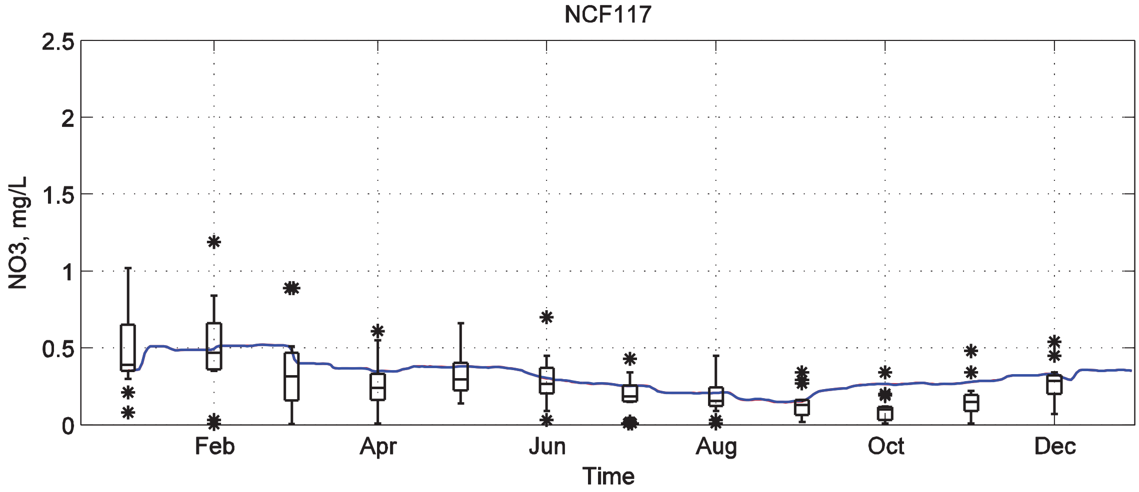

M54
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

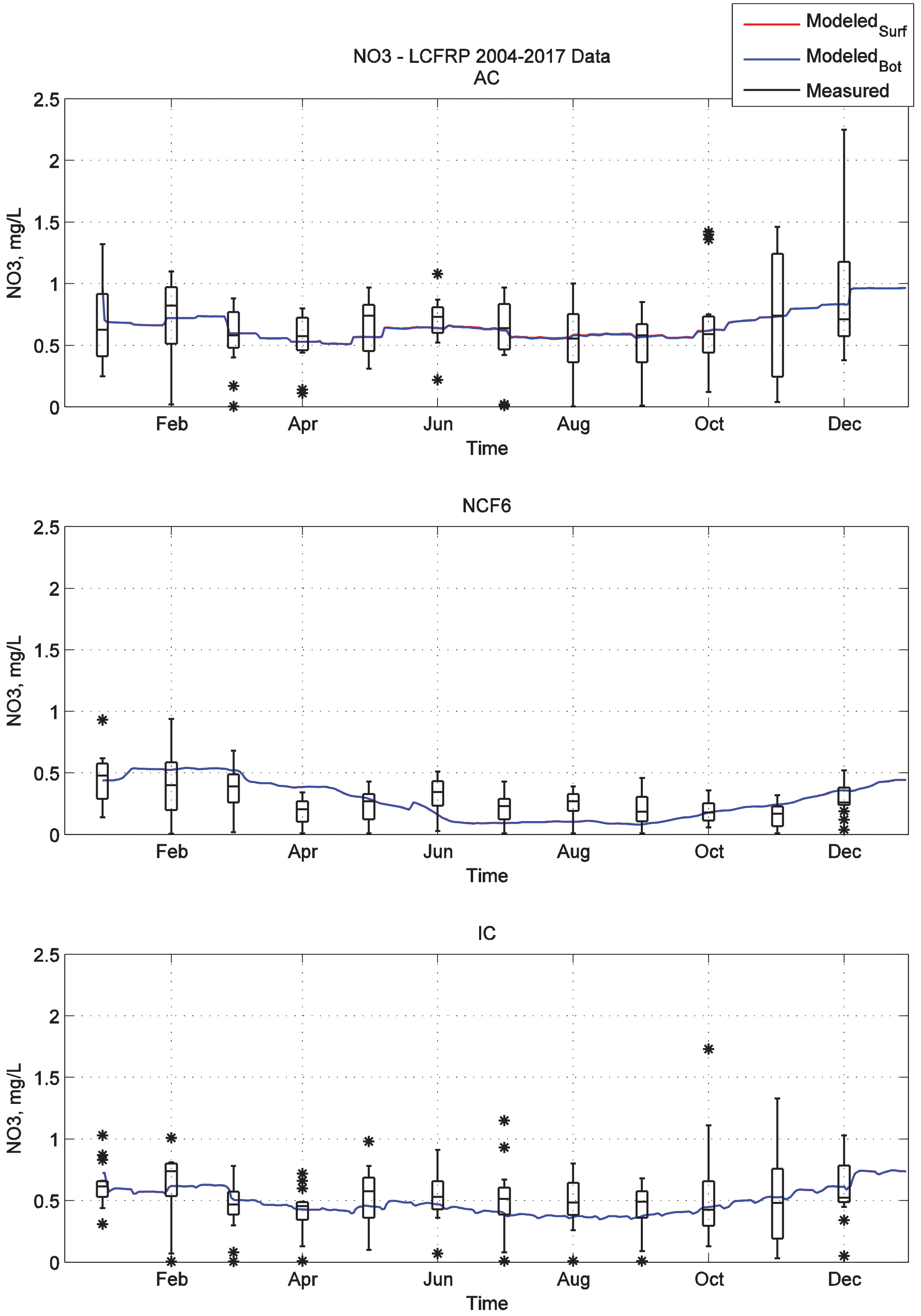

M35
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

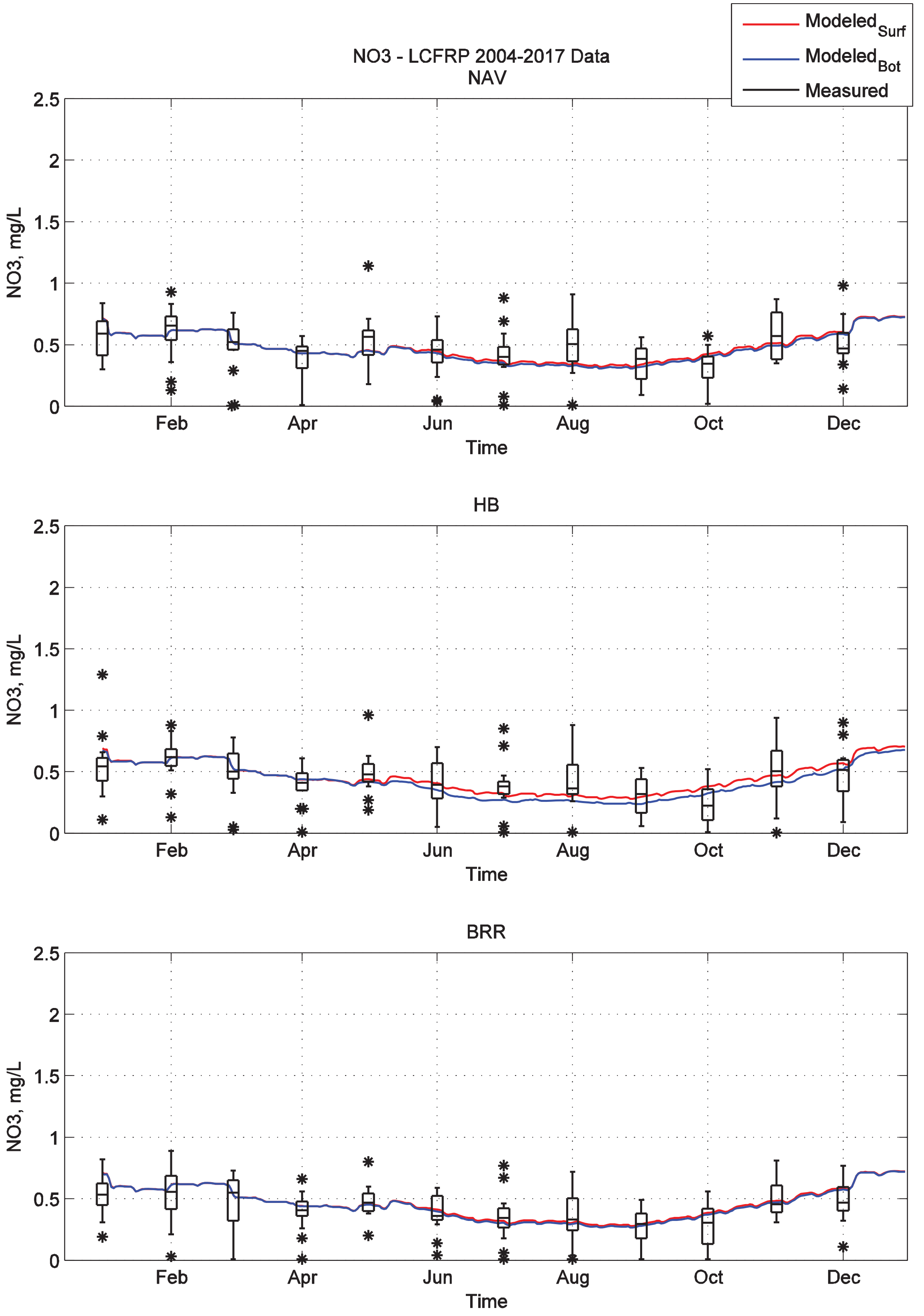

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NH4 - LCFRP 2004-2017 Data
M23
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
NH4, mg/L
0.5
0.4
0.3
0.2
0.1
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

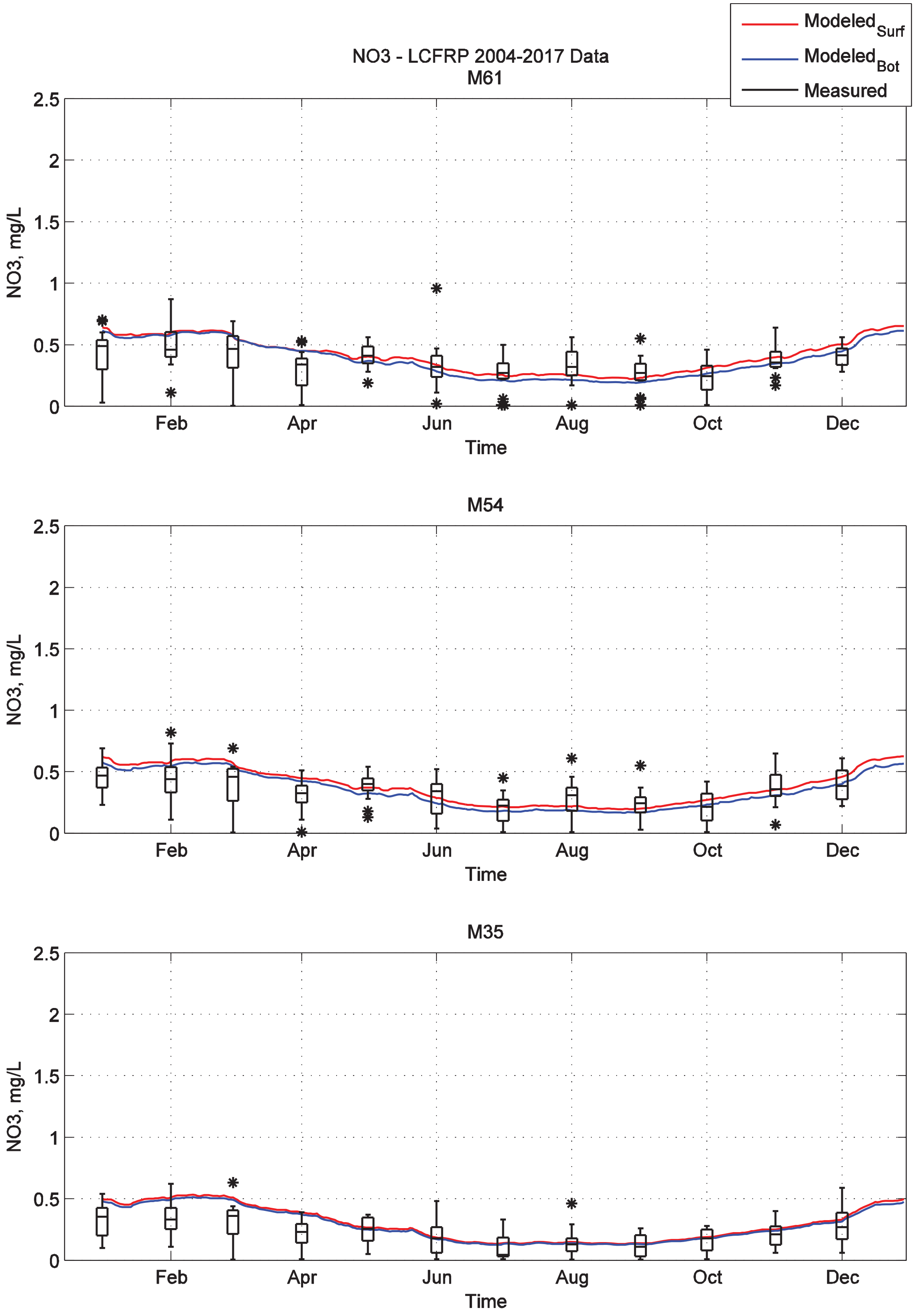

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NO3 - LCFRP 2004-2017 Data
B210
NO3, mg/L
2.5
2
1.5
1
0.5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

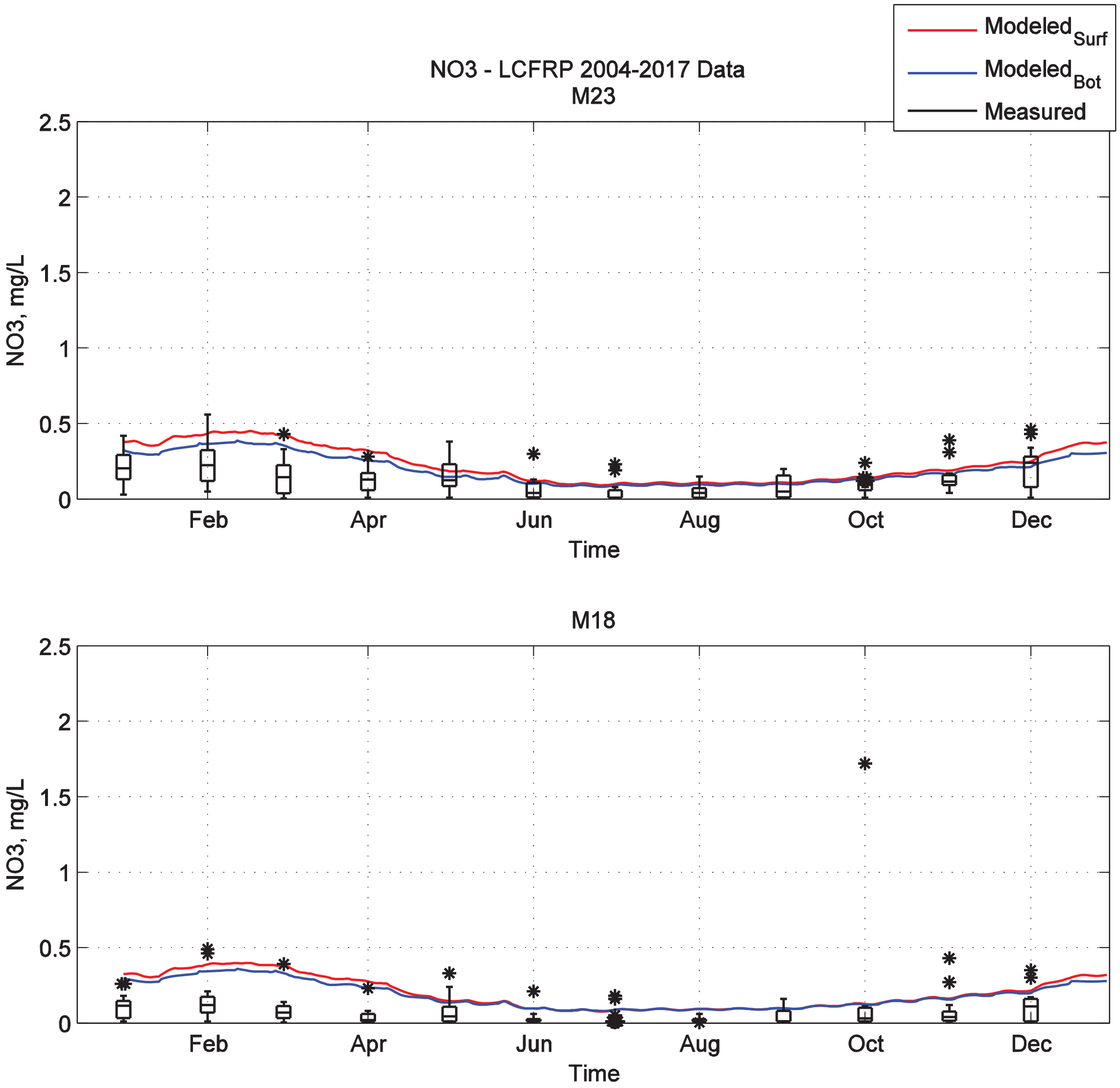

NC11
NO3, mg/L
2.5
2
1.5
1
0.5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

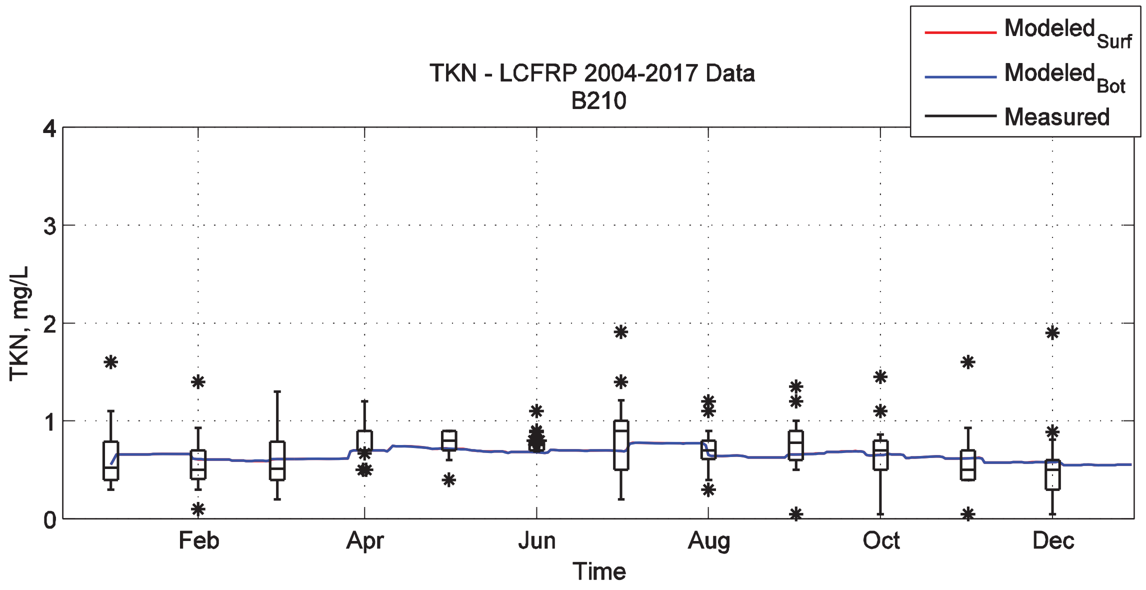

NCF117
NO3, mg/L
2.5
2
1.5
1
0.5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

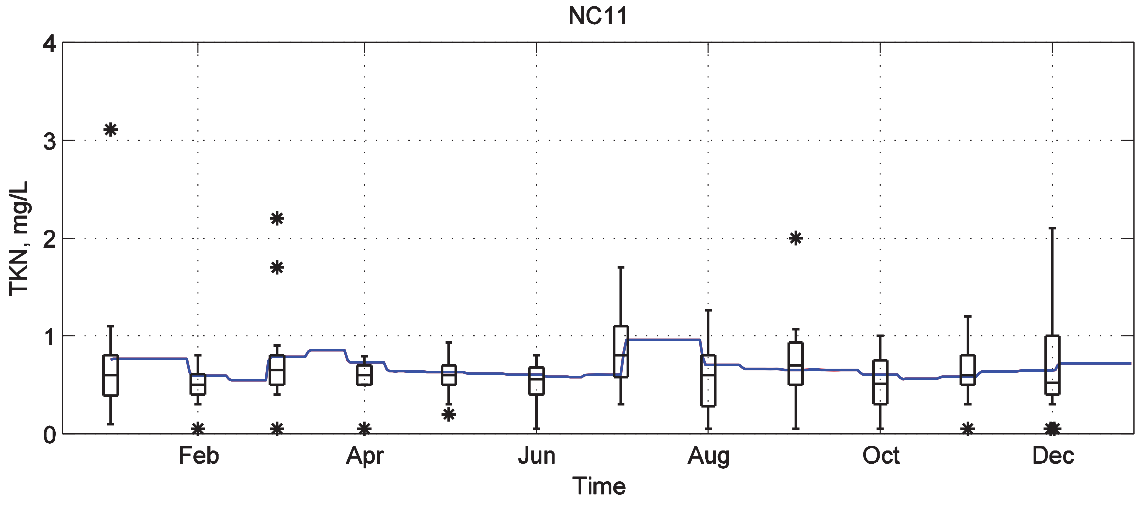

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NO3 - LCFRP 2004-2017 Data
AC
NCF6
IC
NO3, mg/L
2.5
2
1.5
1
0.5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

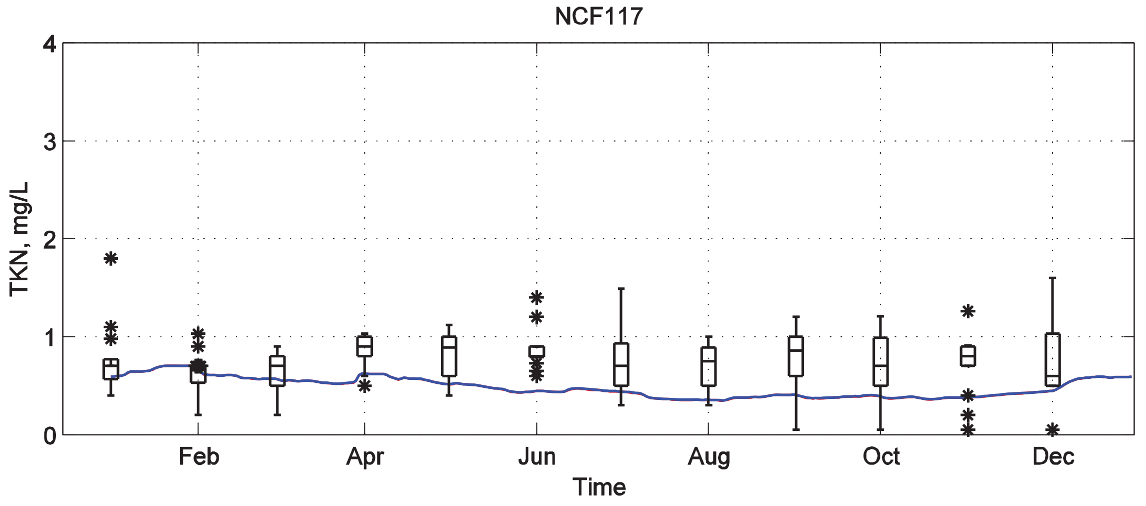

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NO3 - LCFRP 2004-2017 Data
NAV
HB
BRR
NO3, mg/L
2.5
2
1.5
1
0.5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

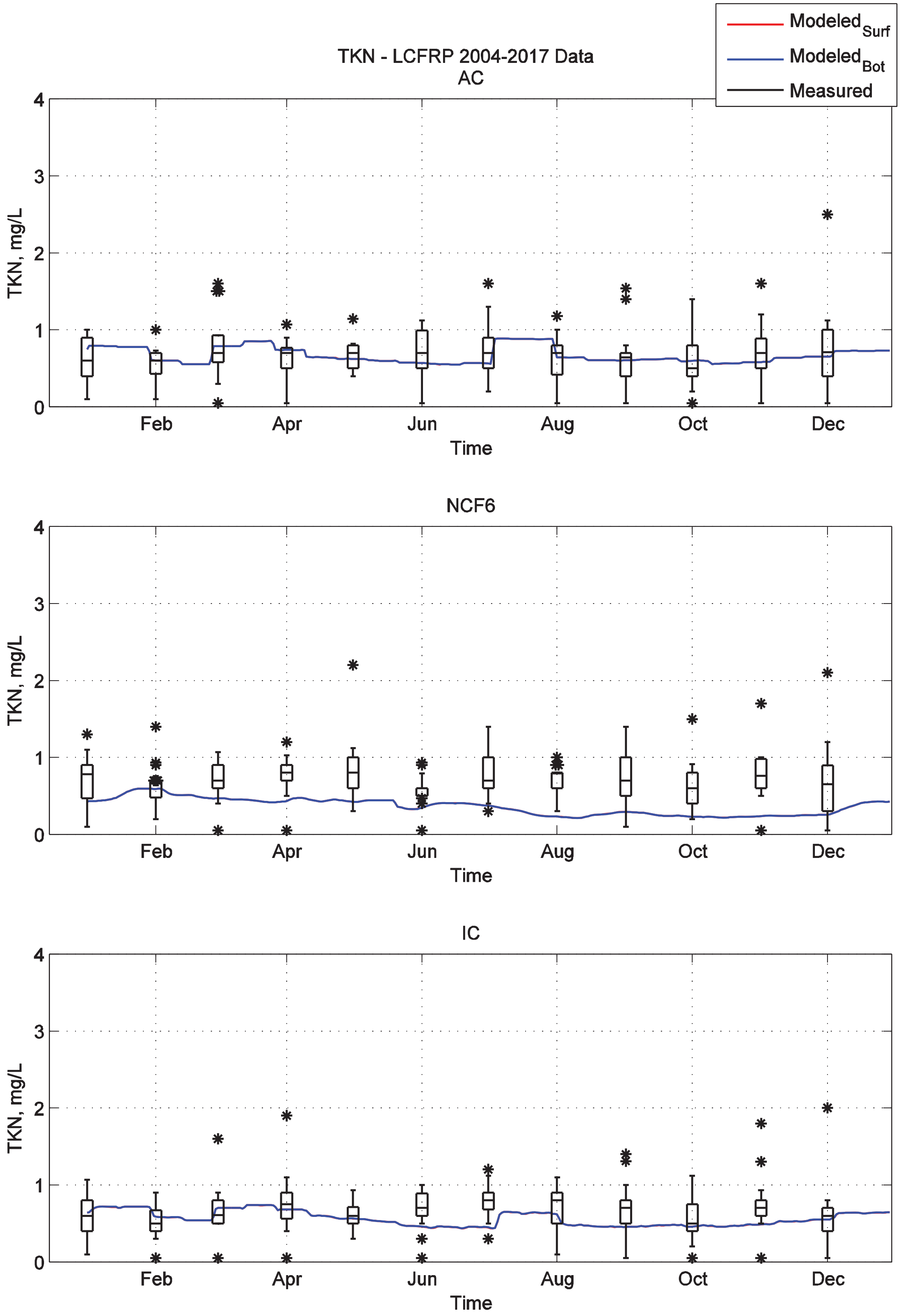

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NO3 - LCFRP 2004-2017 Data
M61
M54
M35
NO3, mg/L
0
0.5
1
1.5
2
2.5
Feb
Apr
Jun
Aug
Oct
Dec
Time

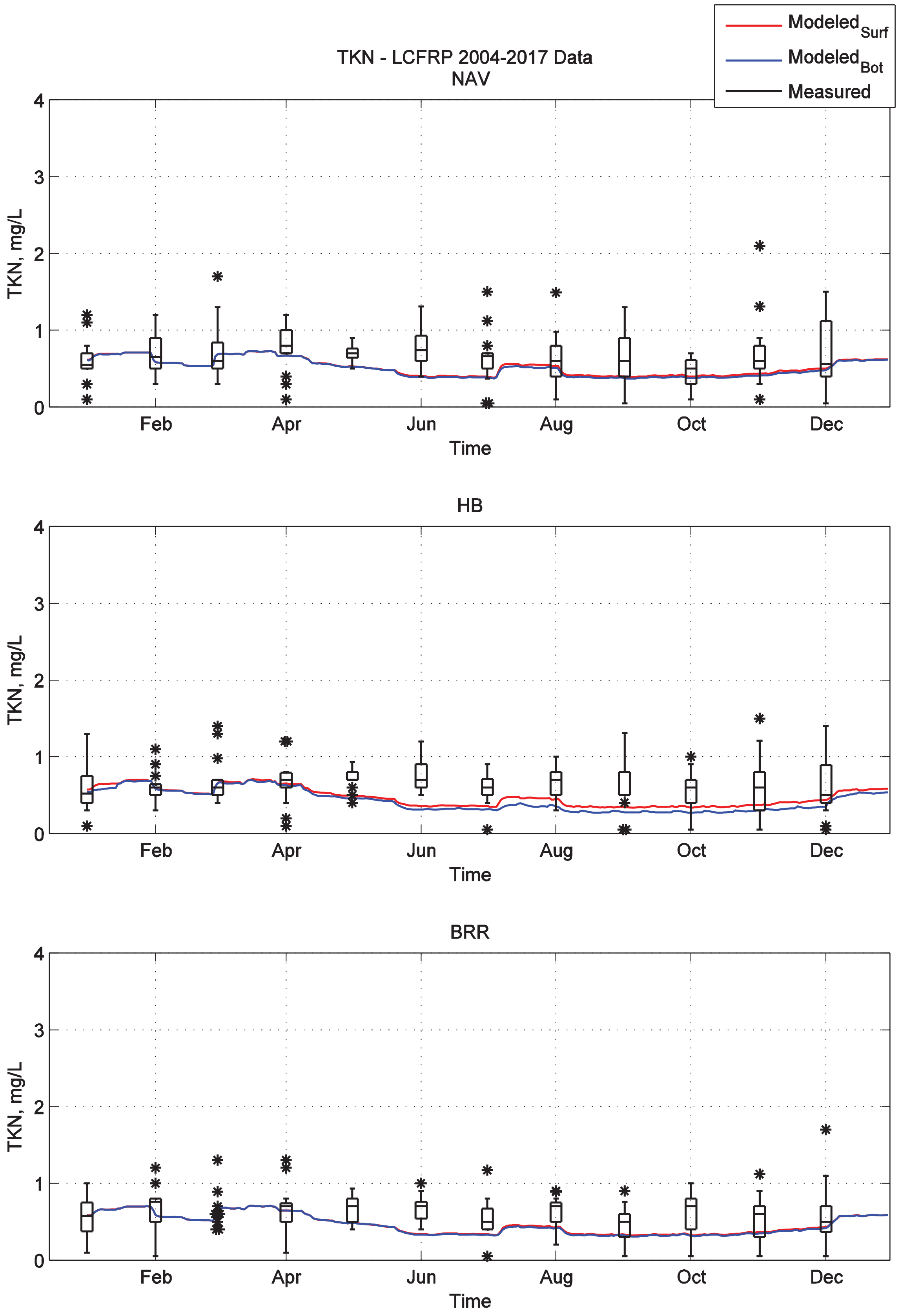

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
NO3 - LCFRP 2004-2017 Data
M23
2.5
2
1.5
1
0.5
0
NO3, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
2.5
2
1.5
1
0.5
0
NO3, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

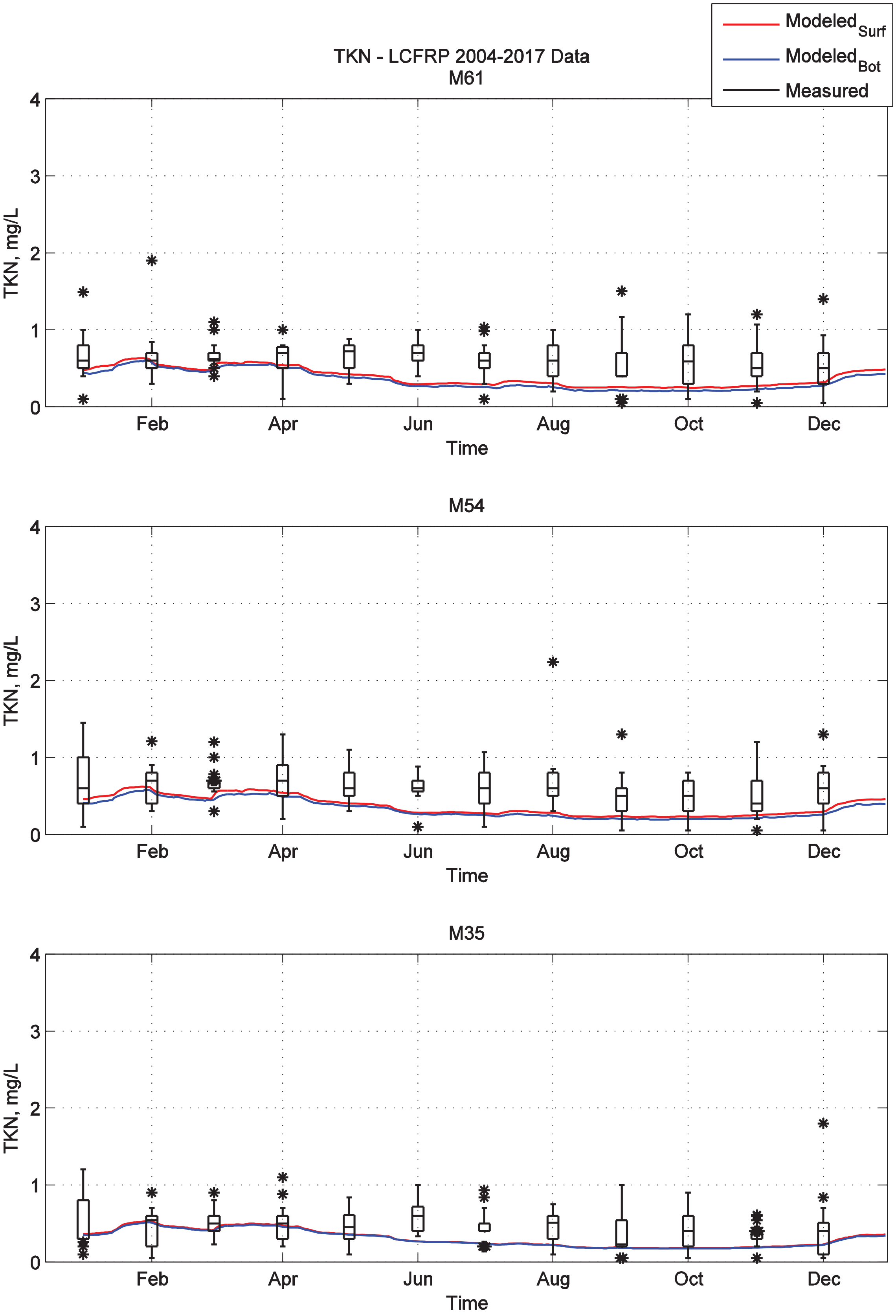

TKN - LCFRP 2004-2017 Data
B210

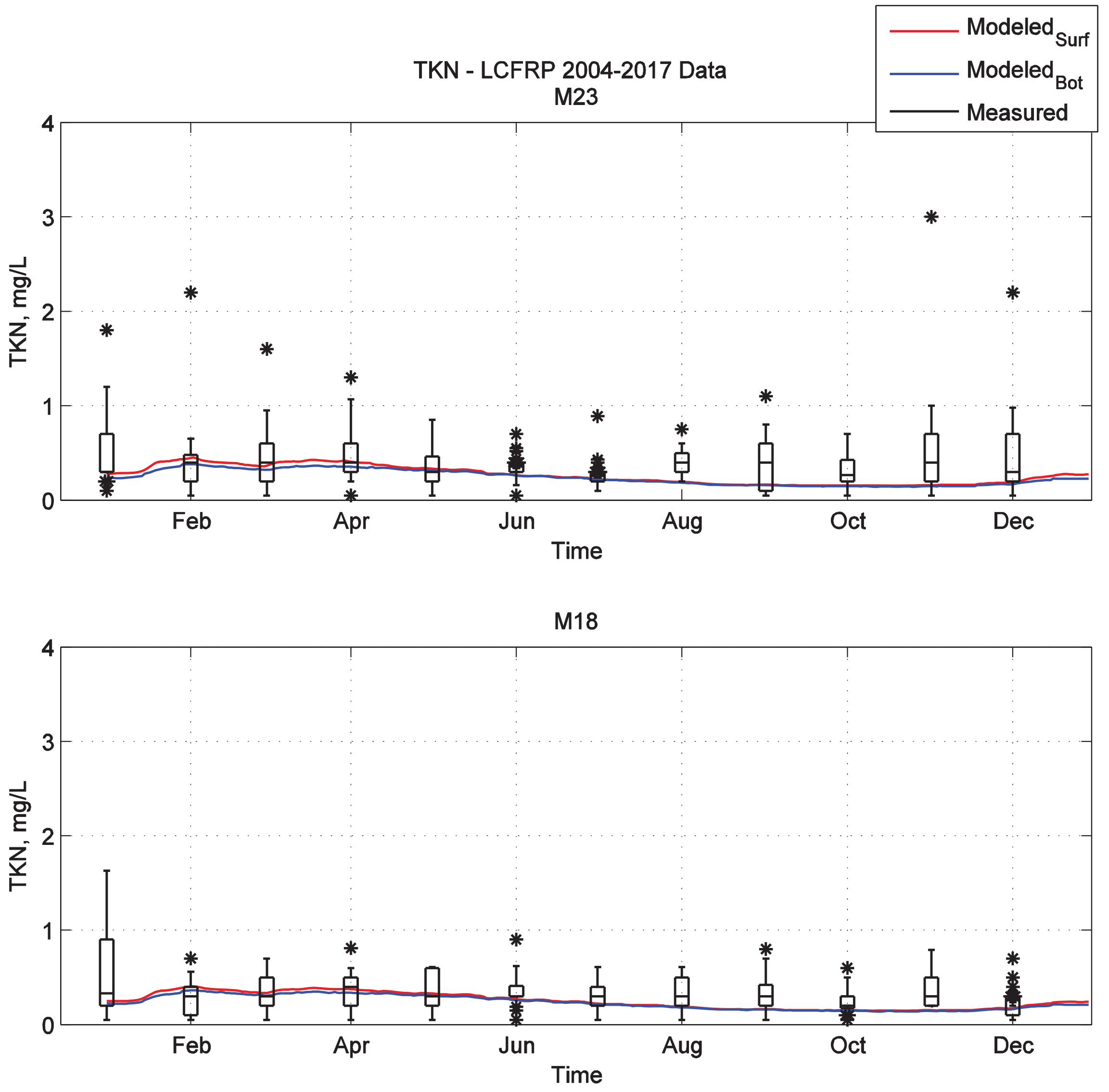

NC11

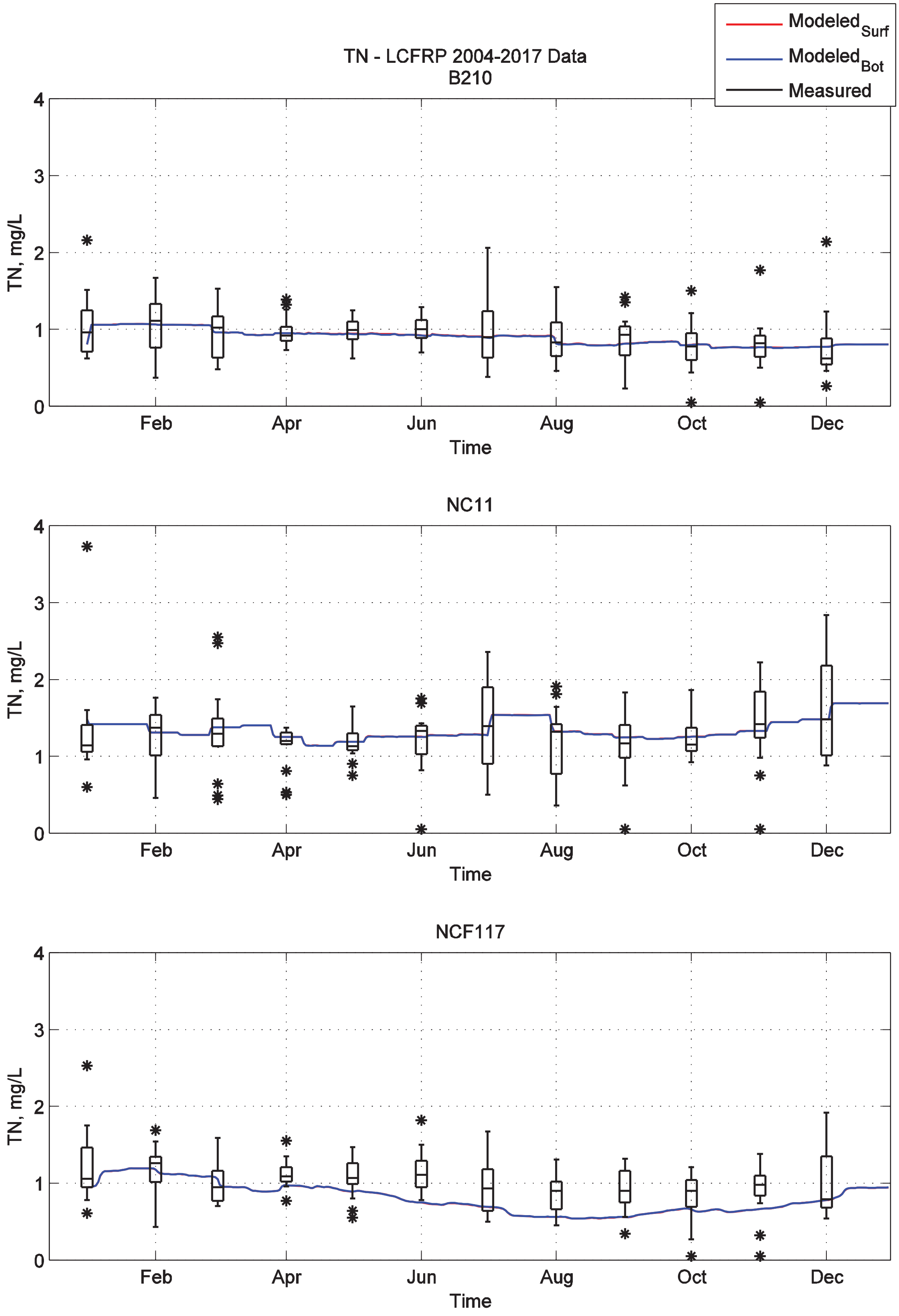

NCF117

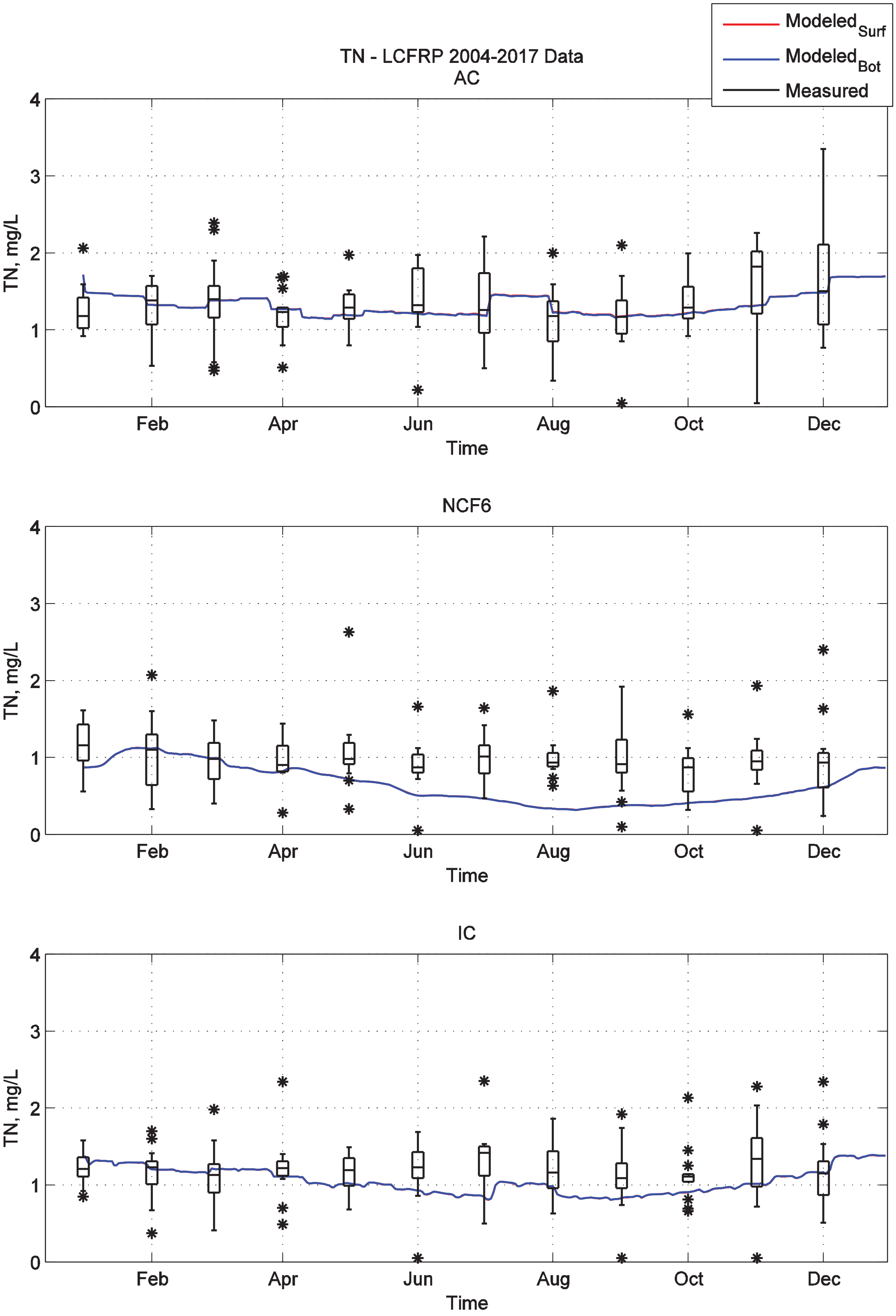

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TKN - LCFRP 2004-2017 Data
AC
NCF6
IC
TKN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

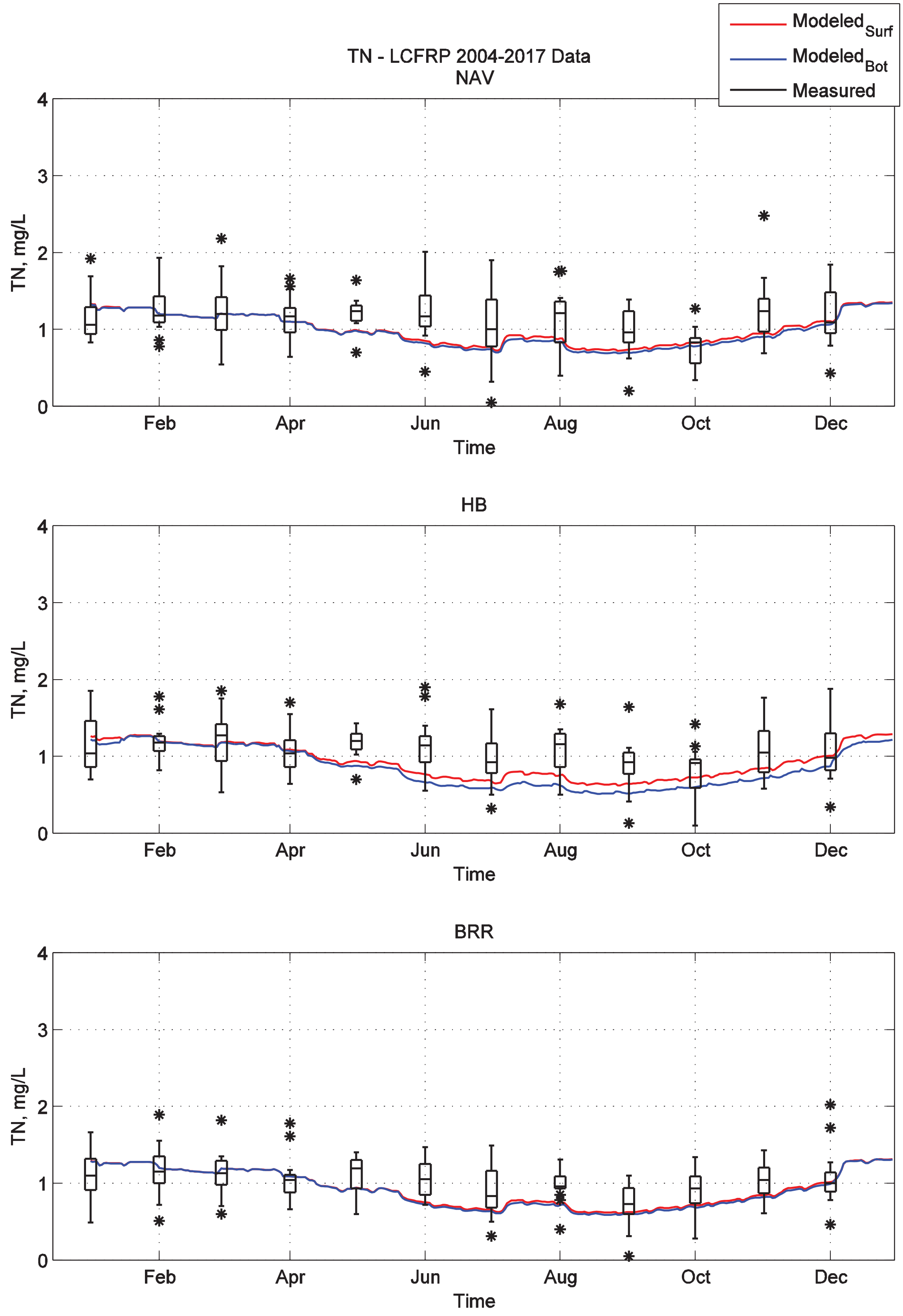

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TKN - LCFRP 2004-2017 Data
NAV
HB
BRR
TKN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

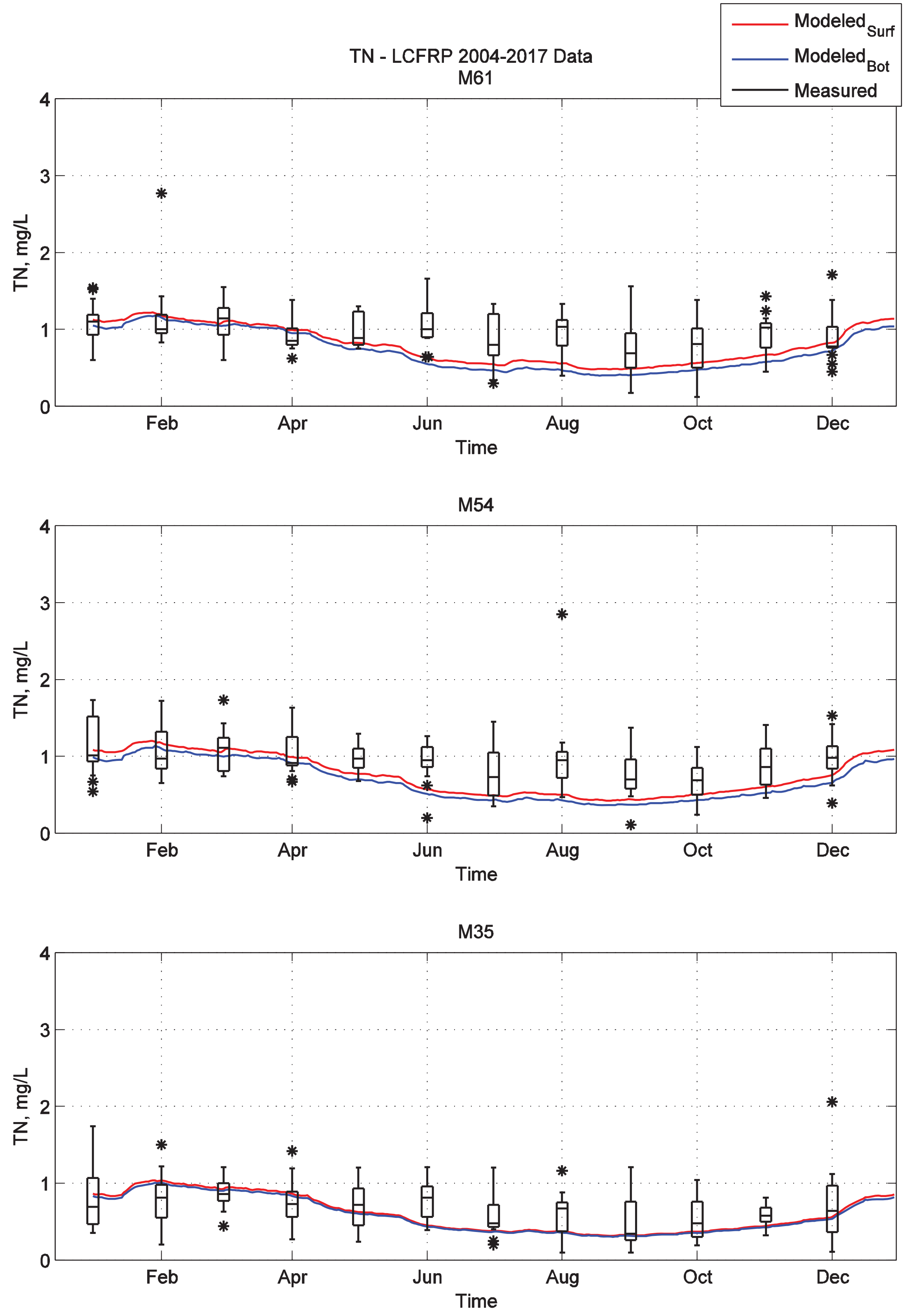

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TKN - LCFRP 2004-2017 Data
M61
M54
M35
TKN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

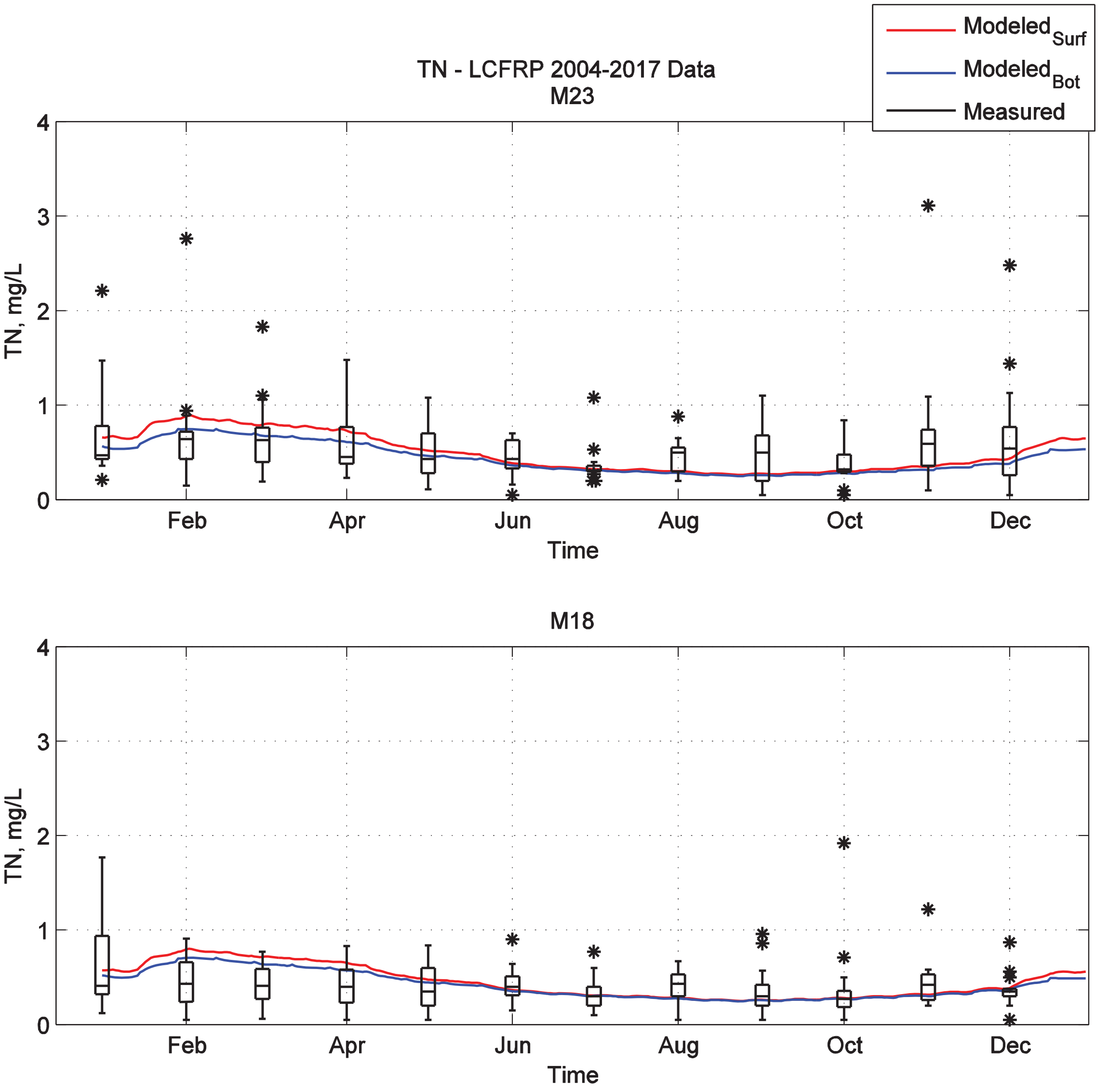

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TKN - LCFRP 2004-2017 Data
M23
TKN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
TKN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

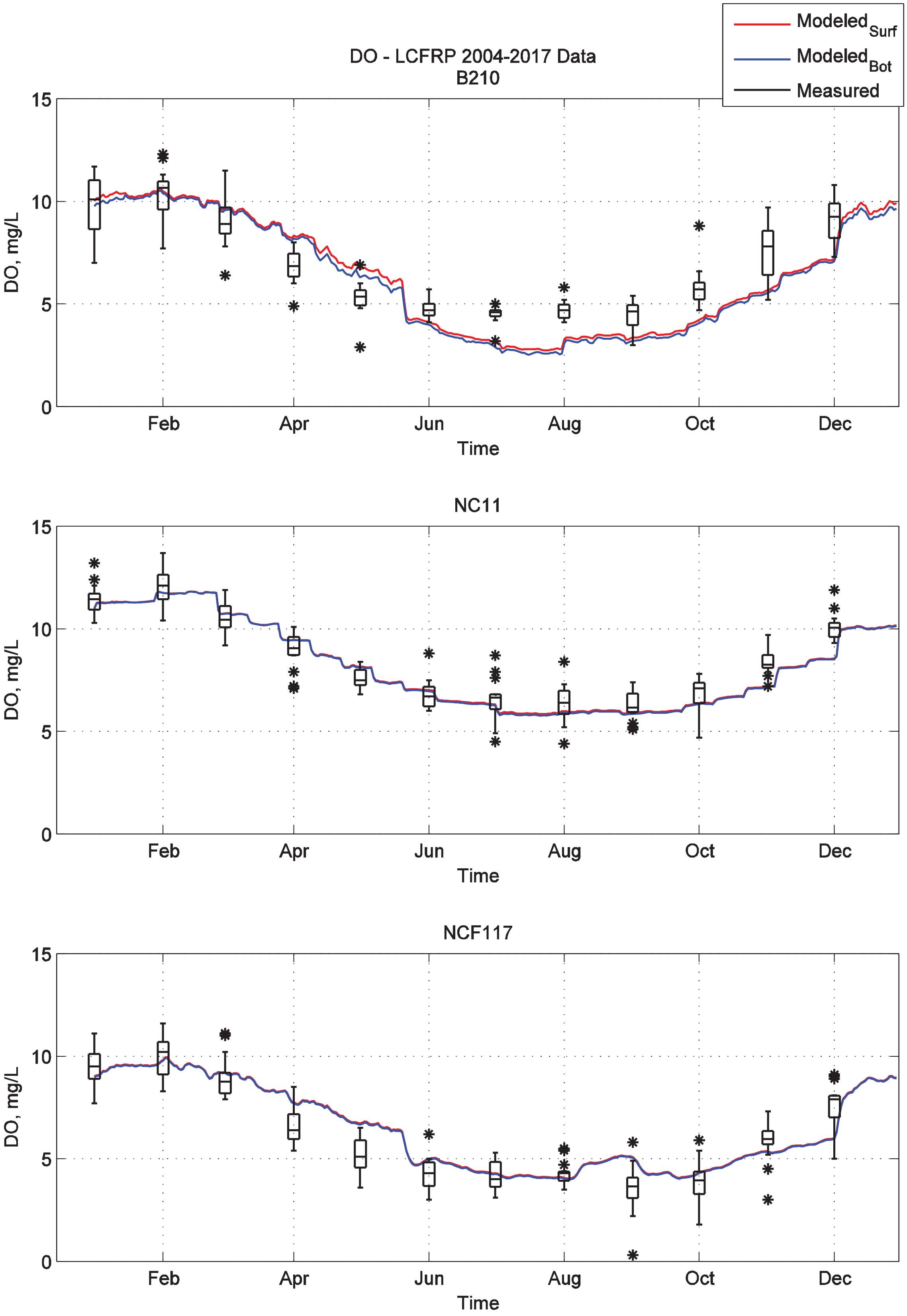

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TN - LCFRP 2004-2017 Data
B210
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time
NC11
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF117
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

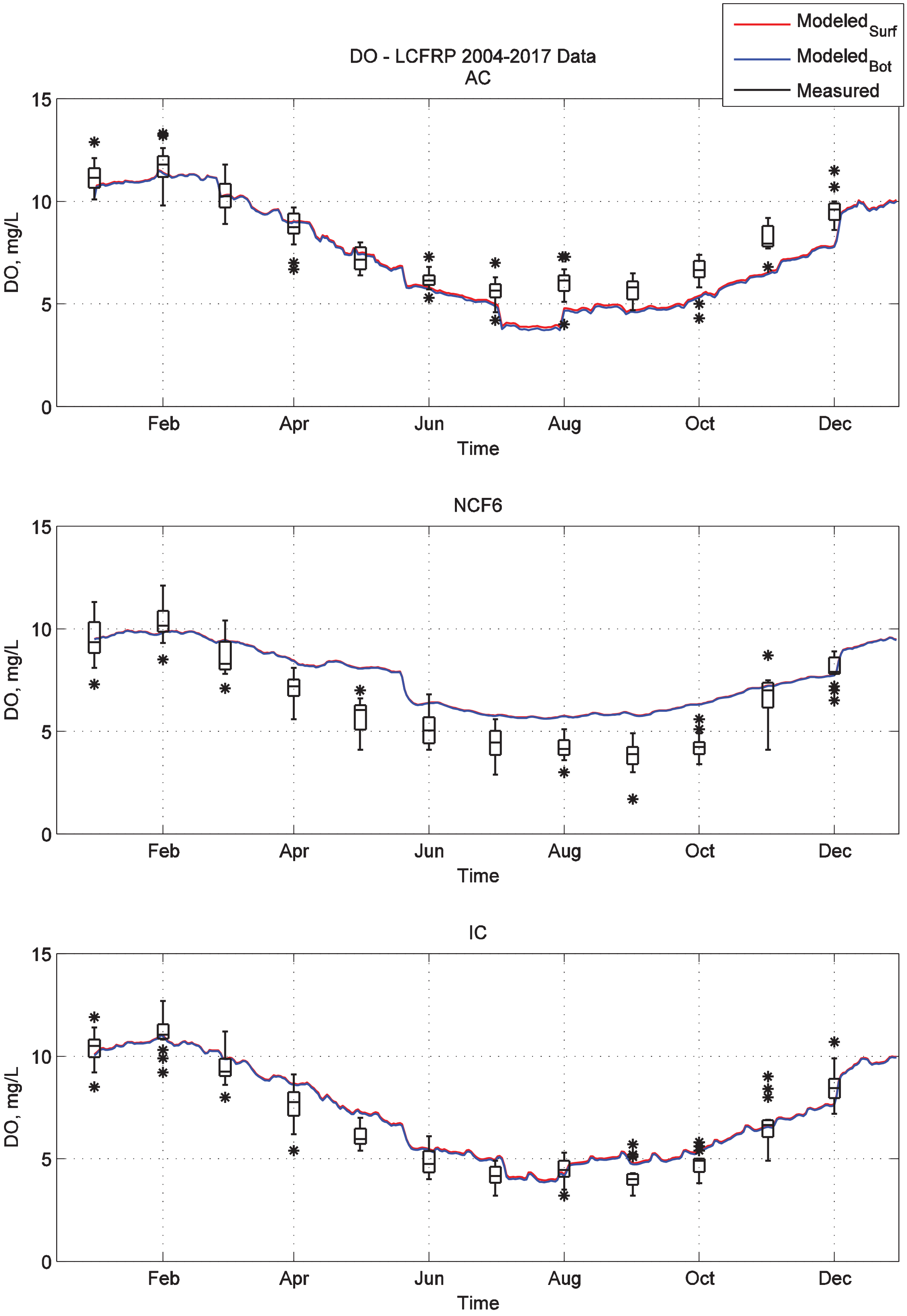

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TN - LCFRP 2004-2017 Data
AC
NCF6
IC
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

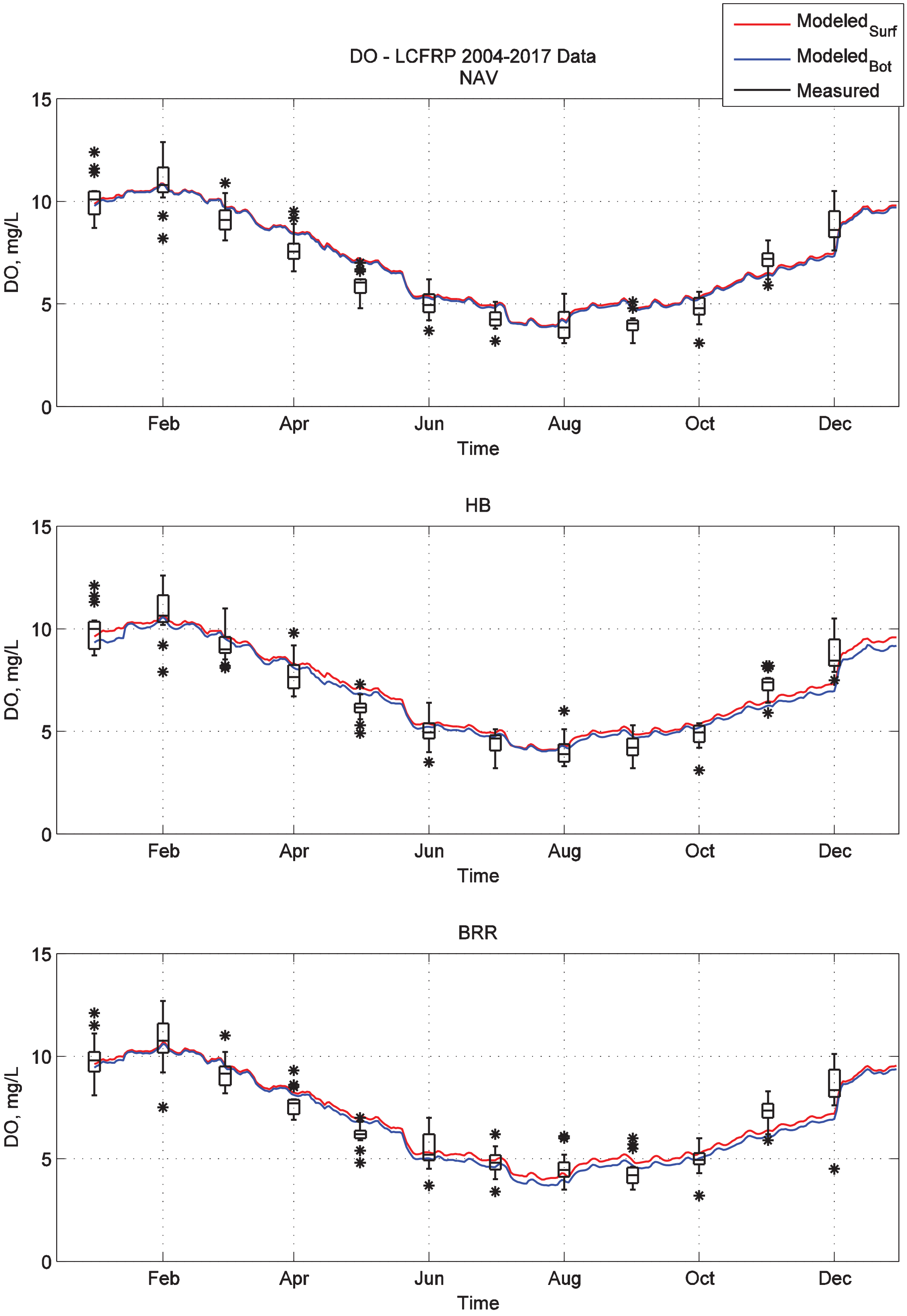

TN - LCFRP 2004-2017 Data
NAV
HB
BRR
Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

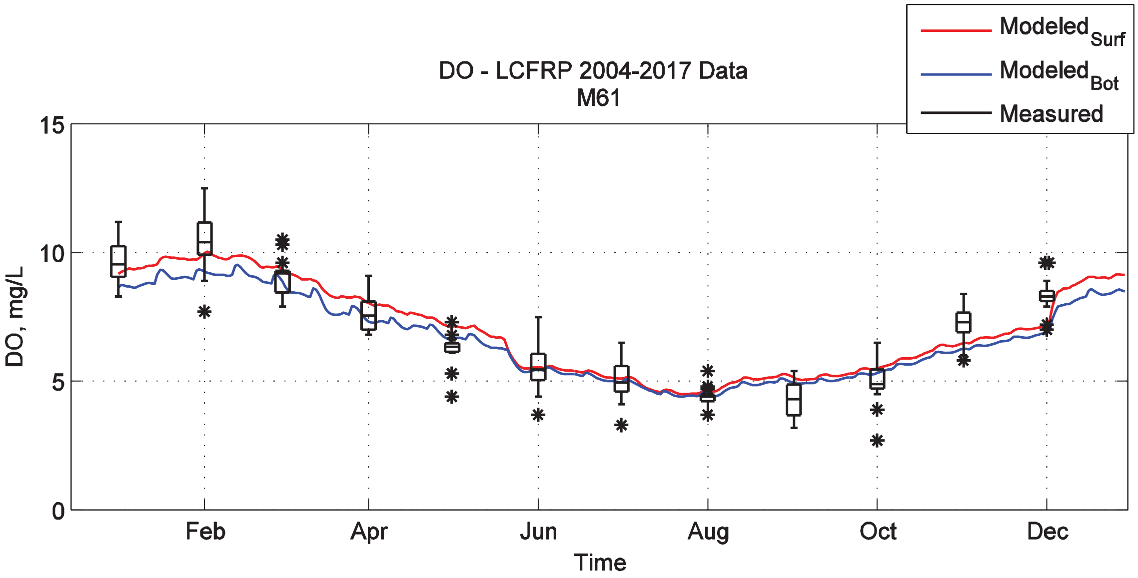

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TN - LCFRP 2004-2017 Data
M61
M54
M35
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

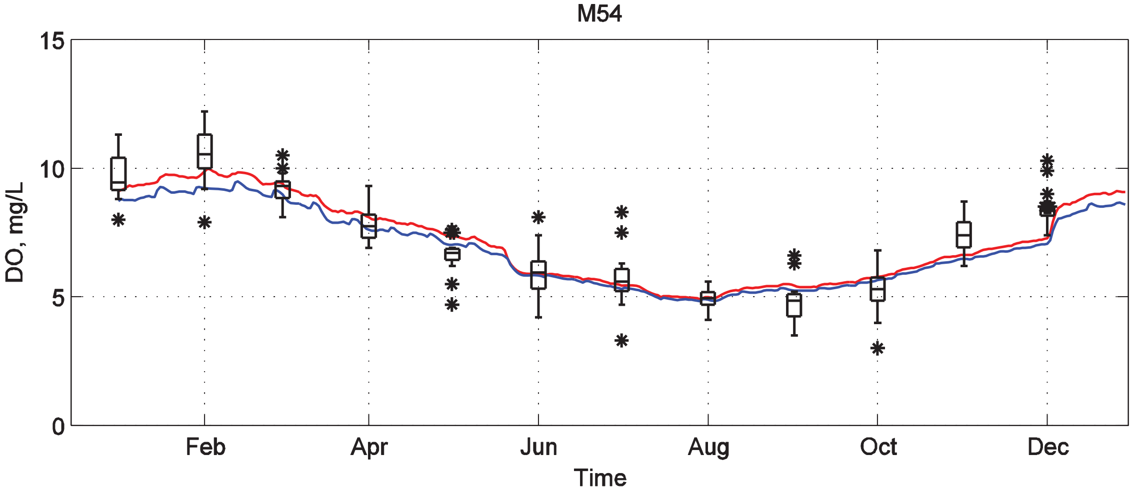

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TN - LCFRP 2004-2017 Data
M23
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
TN, mg/L
0
1
2
3
4
Feb
Apr
Jun
Aug
Oct
Dec
Time

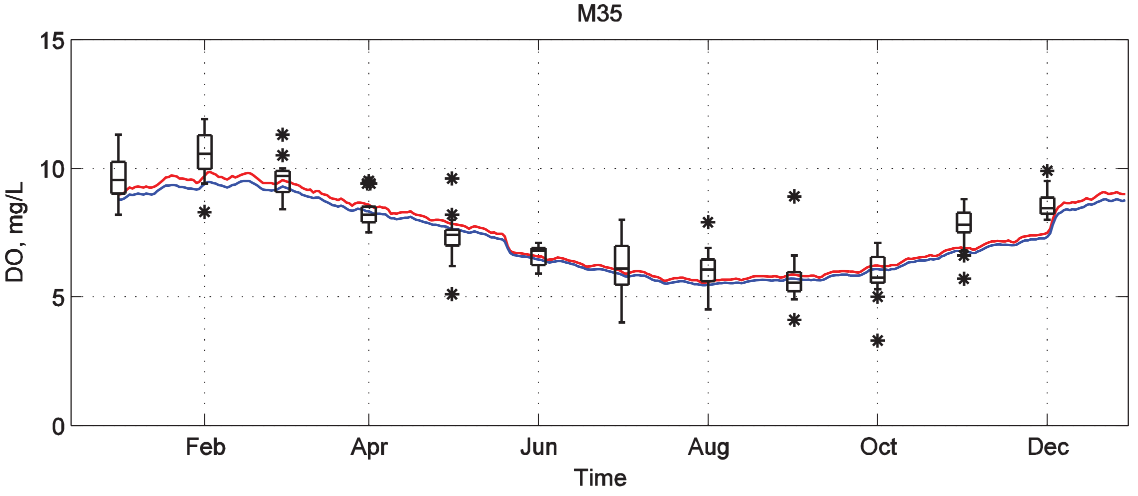

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
DO - LCFRP 2004-2017 Data
B210
NC11
NCF117
DO, mg/L
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

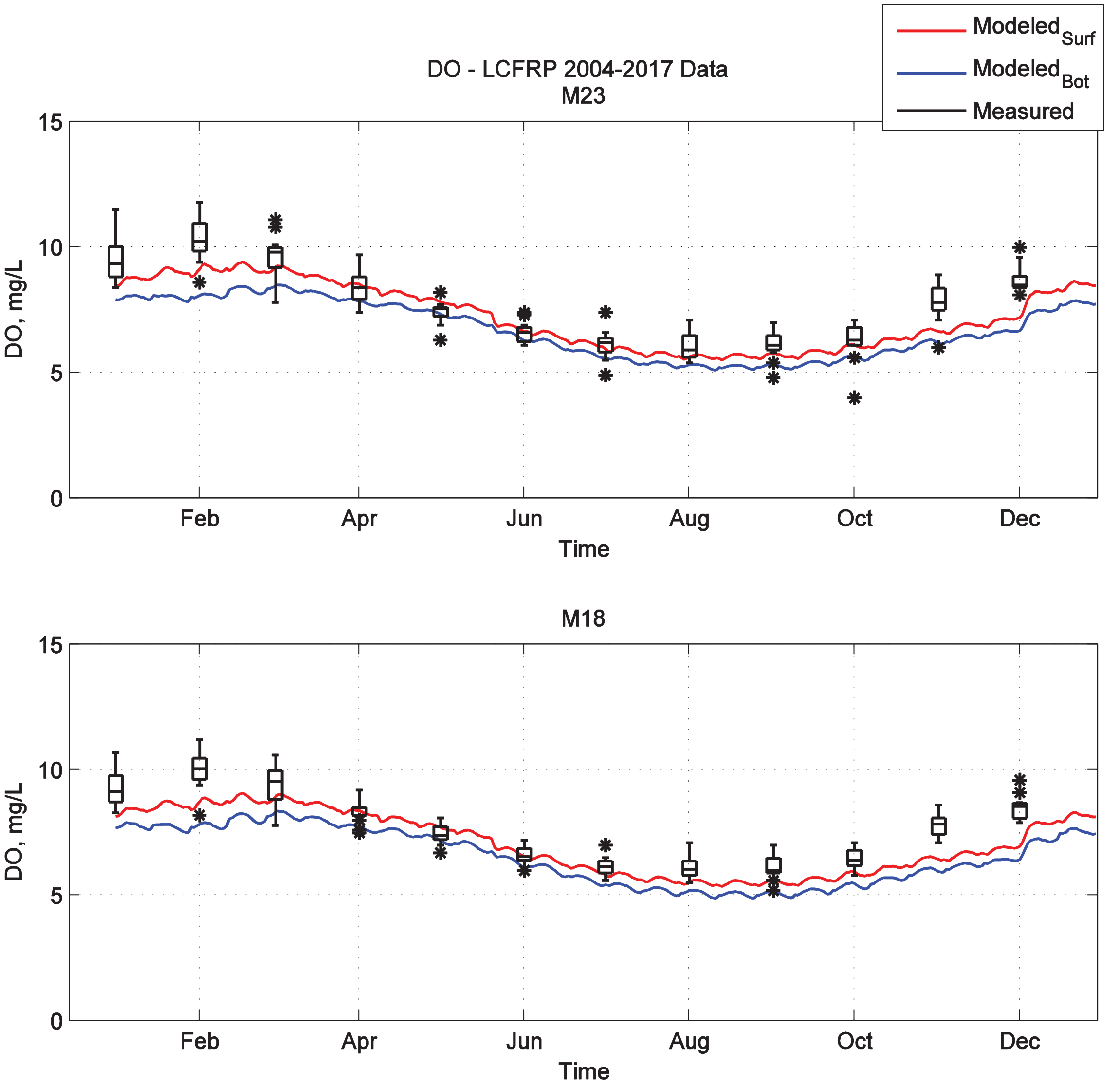

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
DO - LCFRP 2004-2017 Data
AC
NCF6
IC
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time

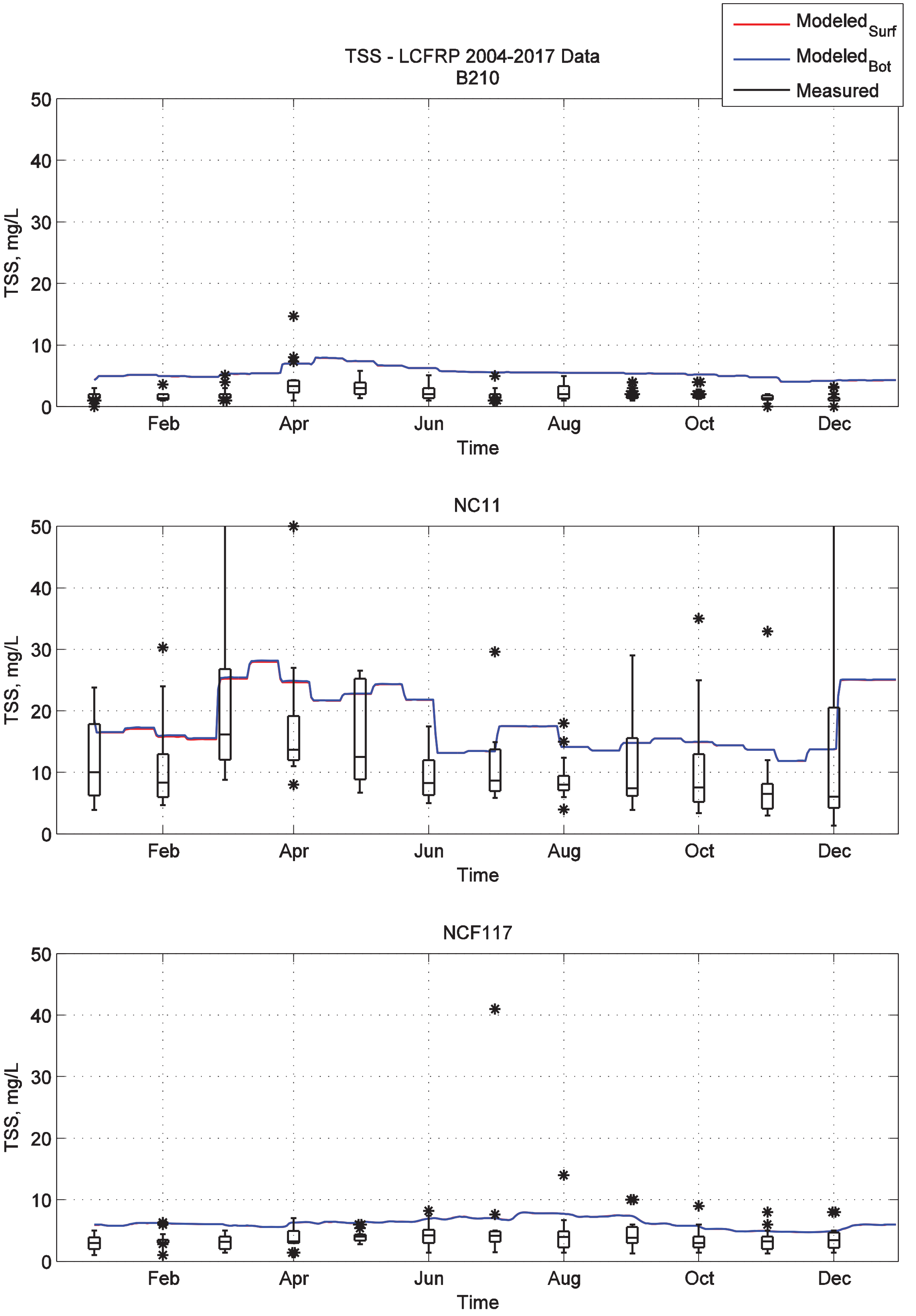

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
DO - LCFRP 2004-2017 Data
NAV
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
HB
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
BRR
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

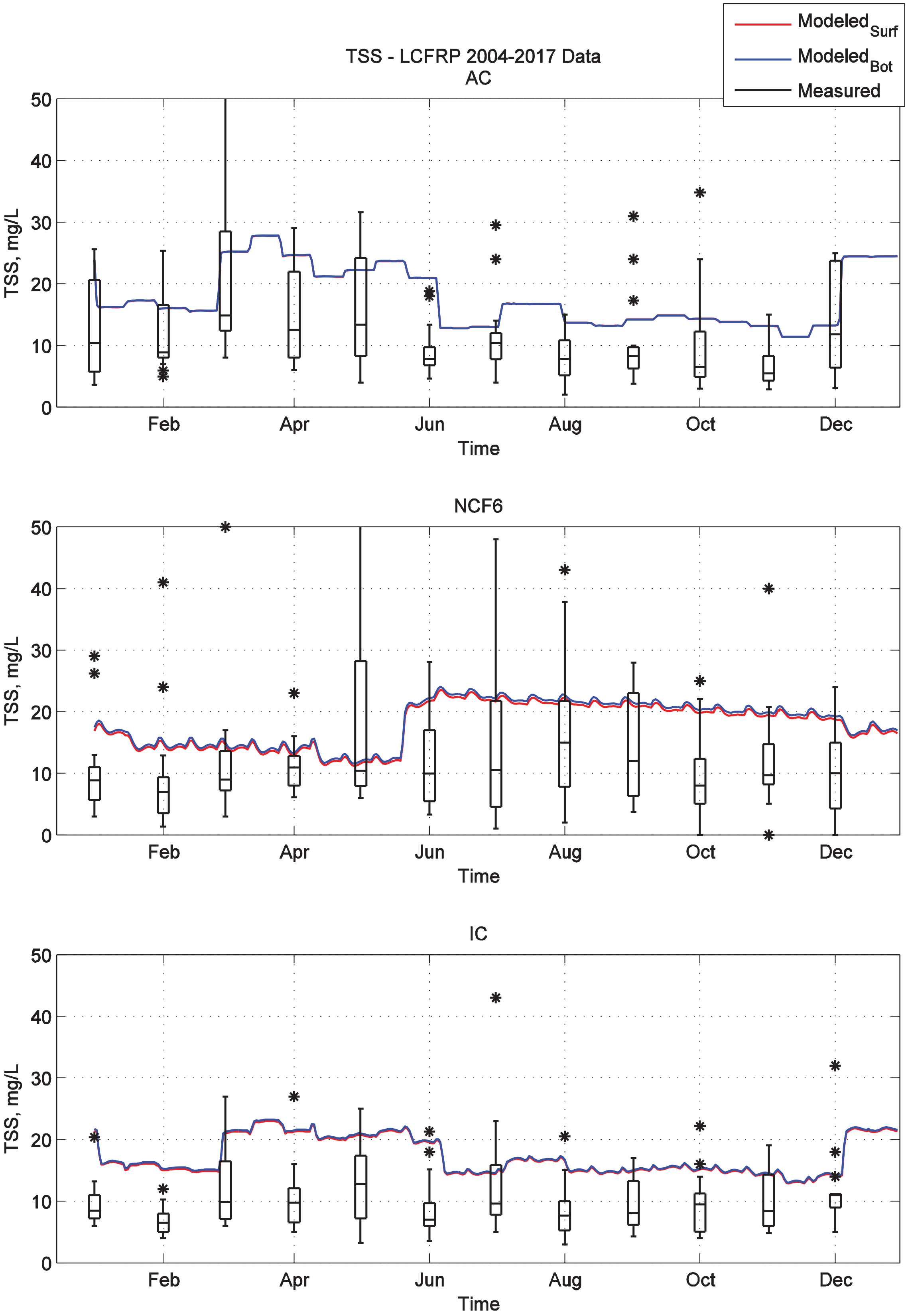

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
DO - LCFRP 2004-2017 Data
M61
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

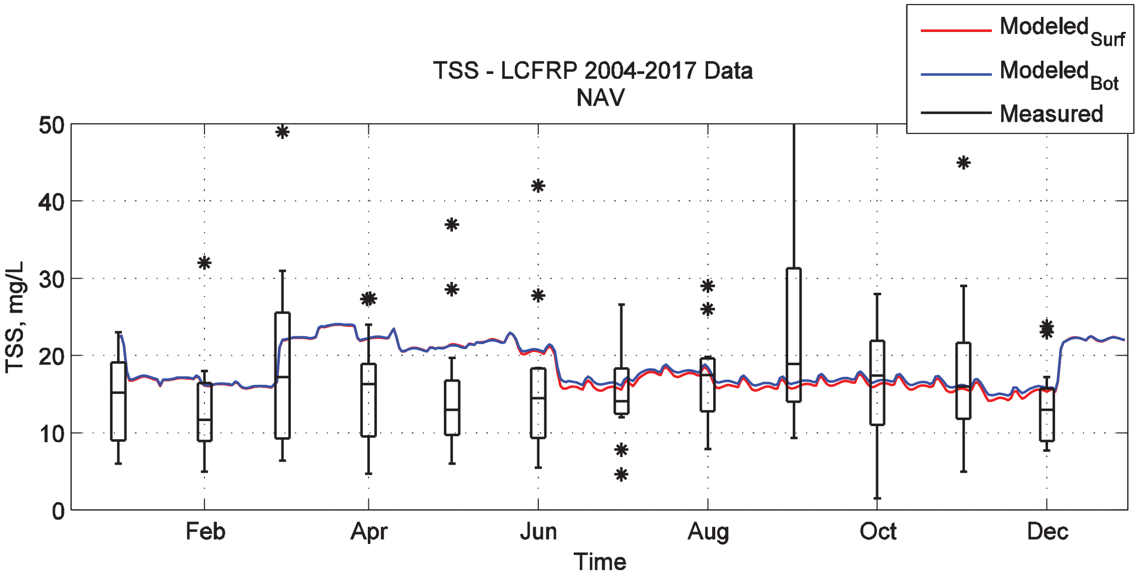

M54
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

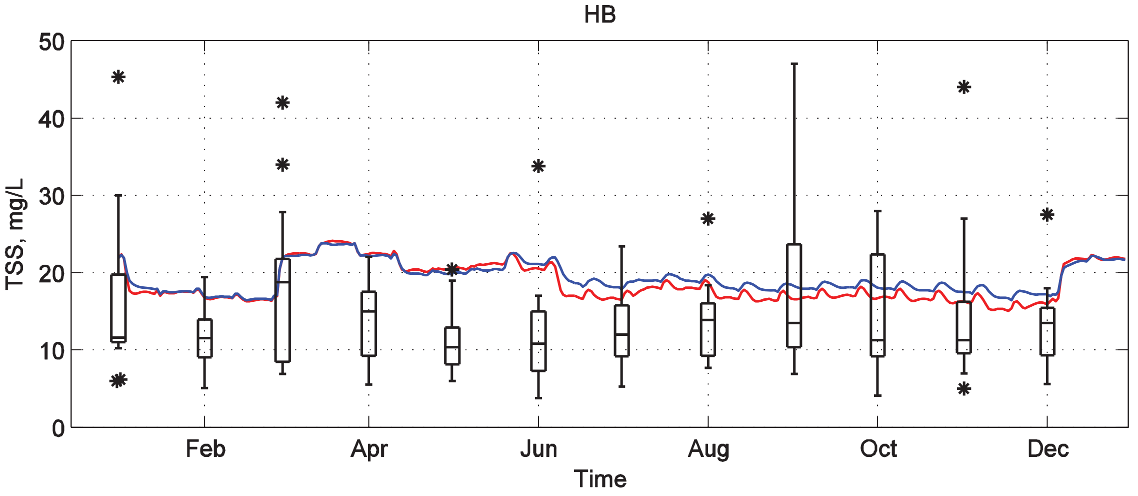

M35
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

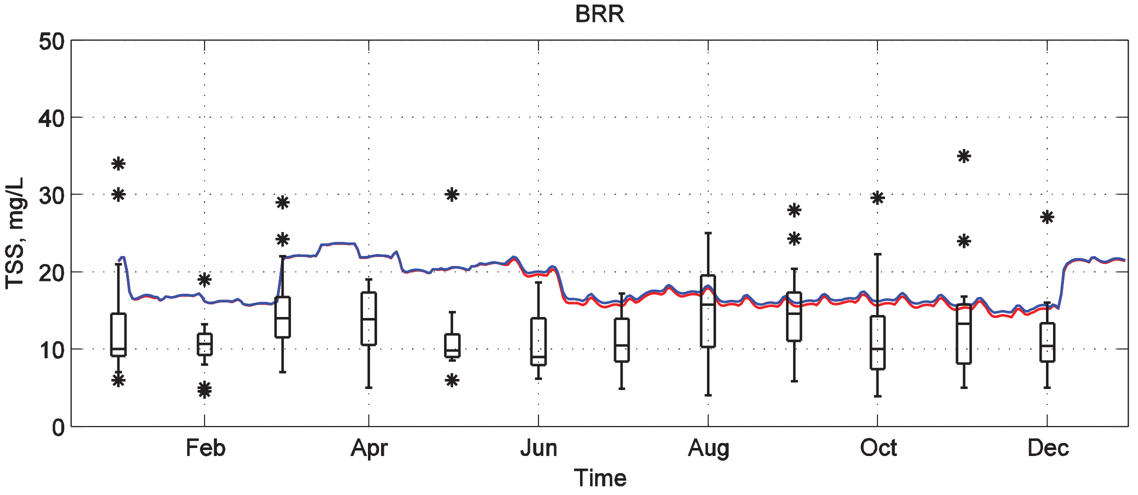

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
DO - LCFRP 2004-2017 Data
M23
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

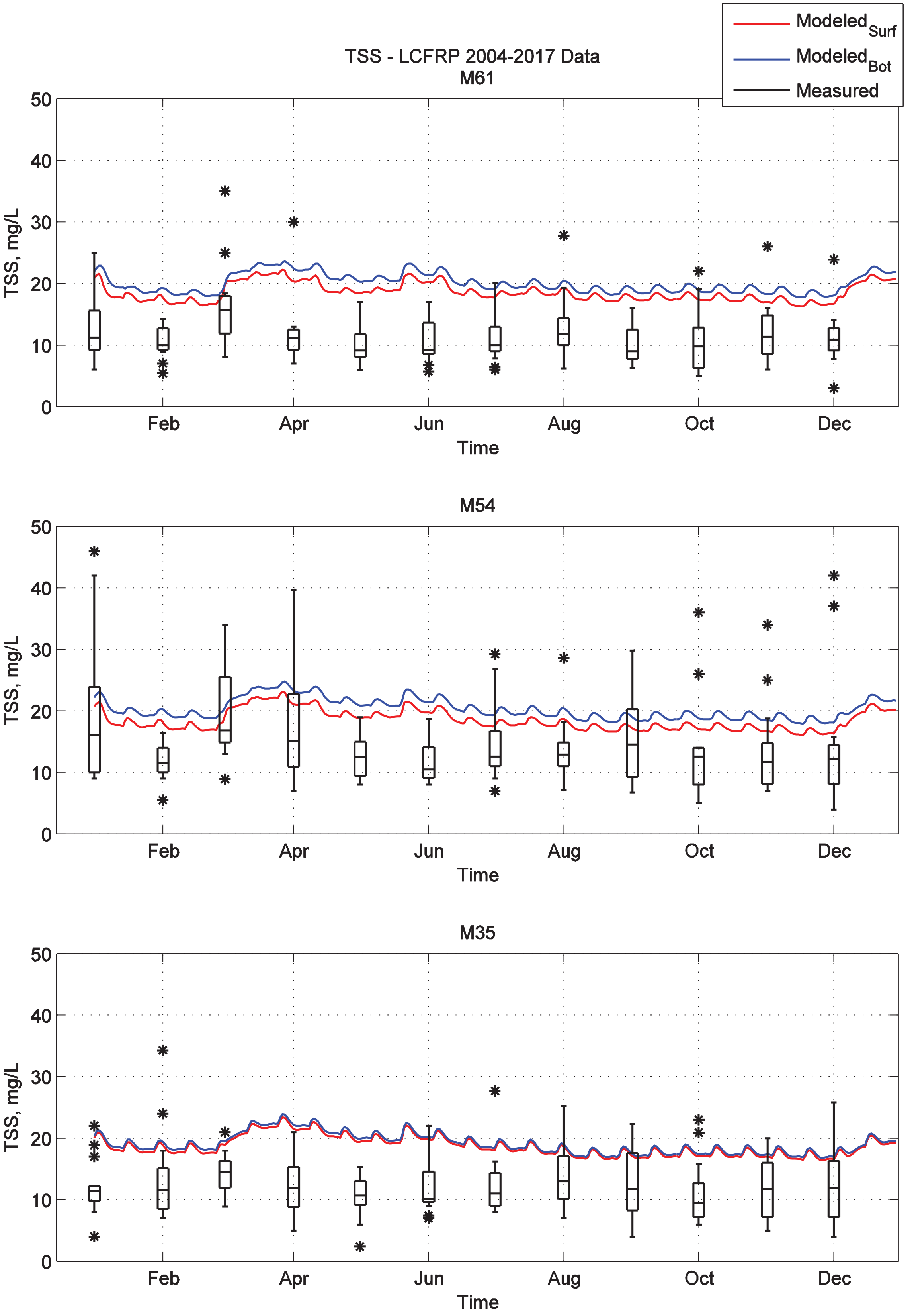

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TSS - LCFRP 2004-2017 Data
B210
NC11
NCF117
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

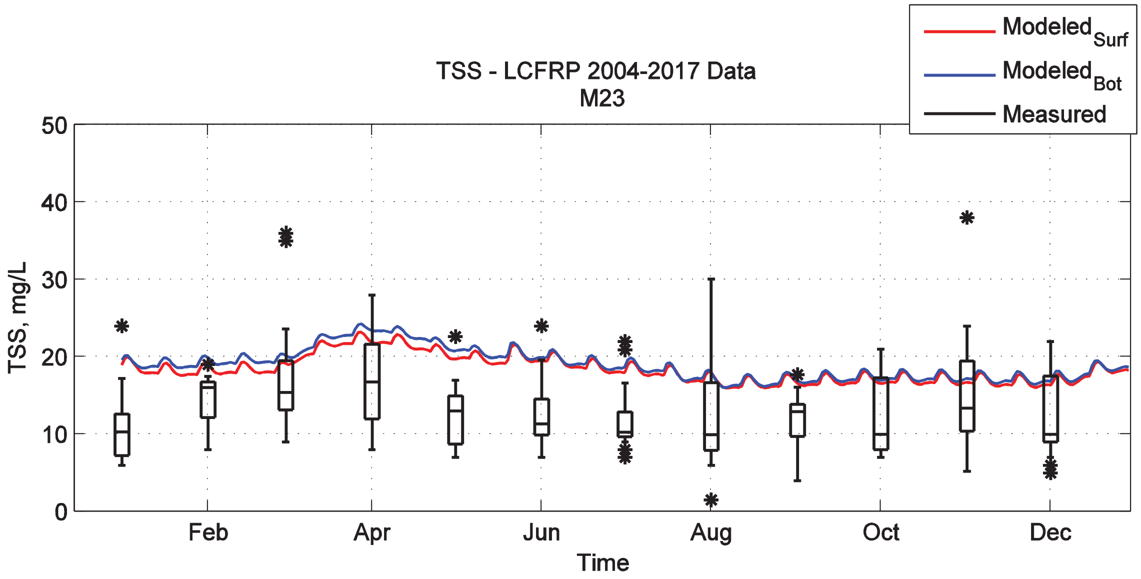

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TSS - LCFRP 2004-2017 Data
AC
NCF6
IC
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

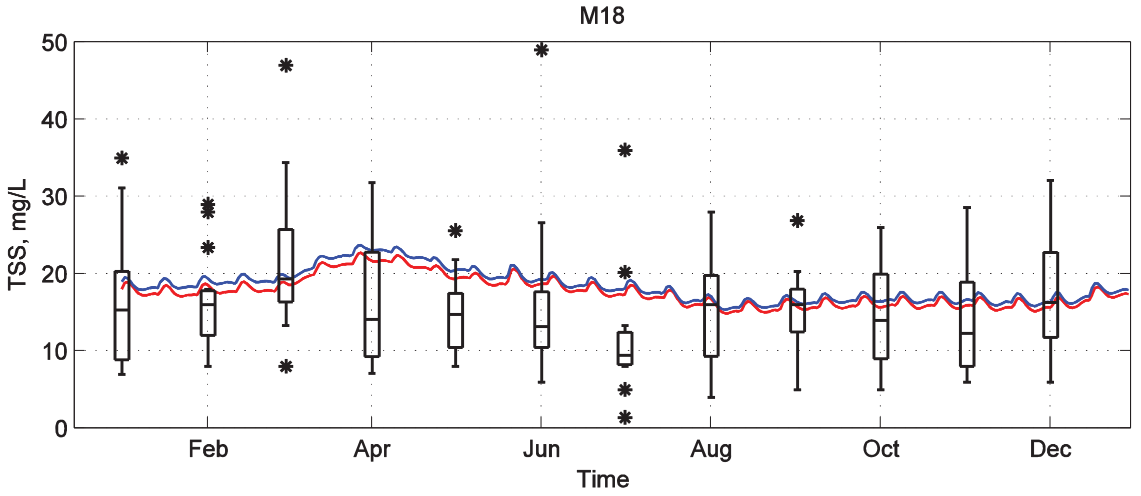

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TSS - LCFRP 2004-2017 Data
NAV
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

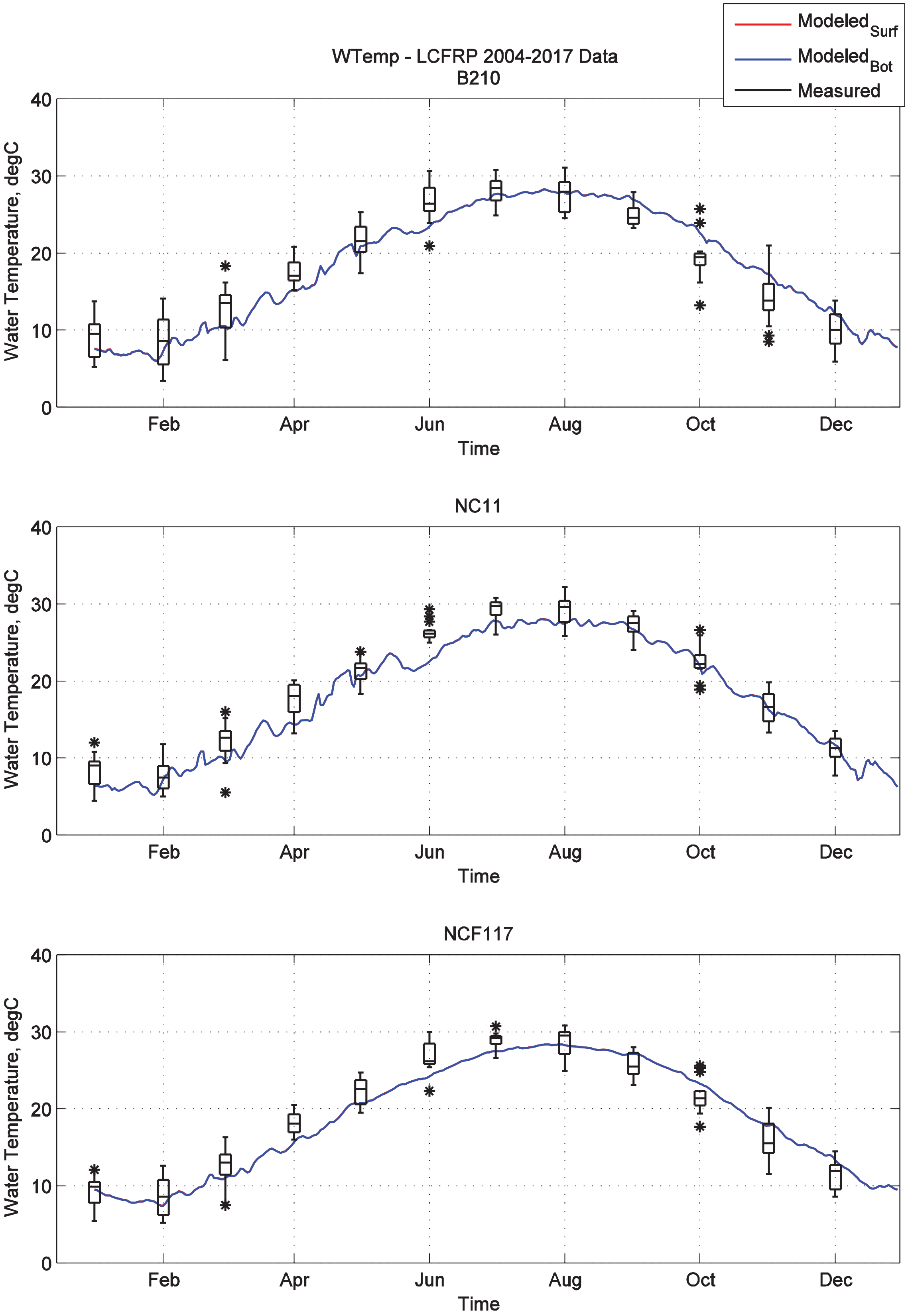

HB
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

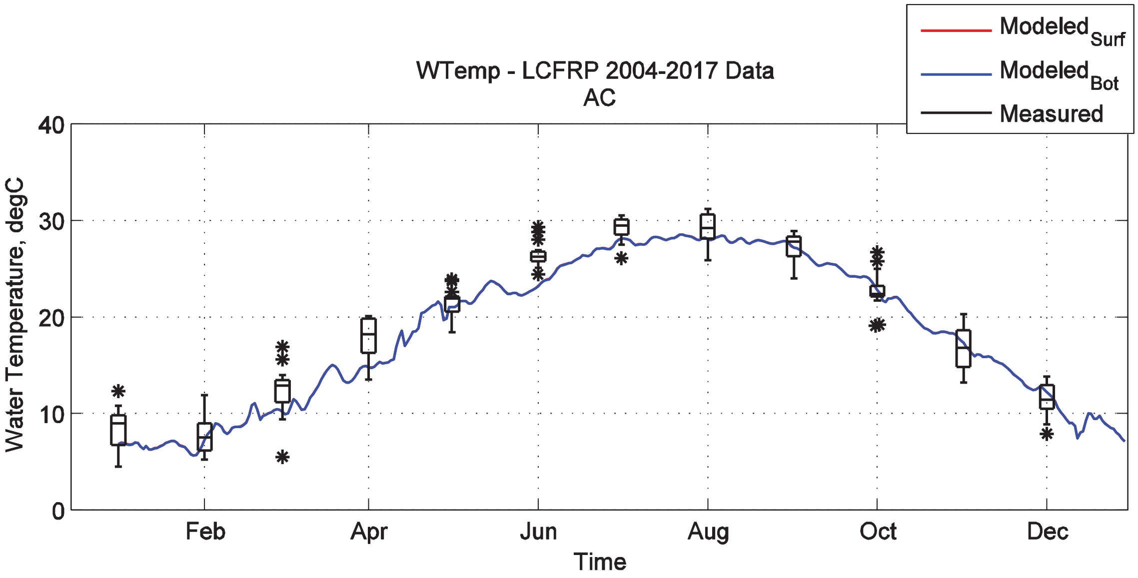

BRR
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

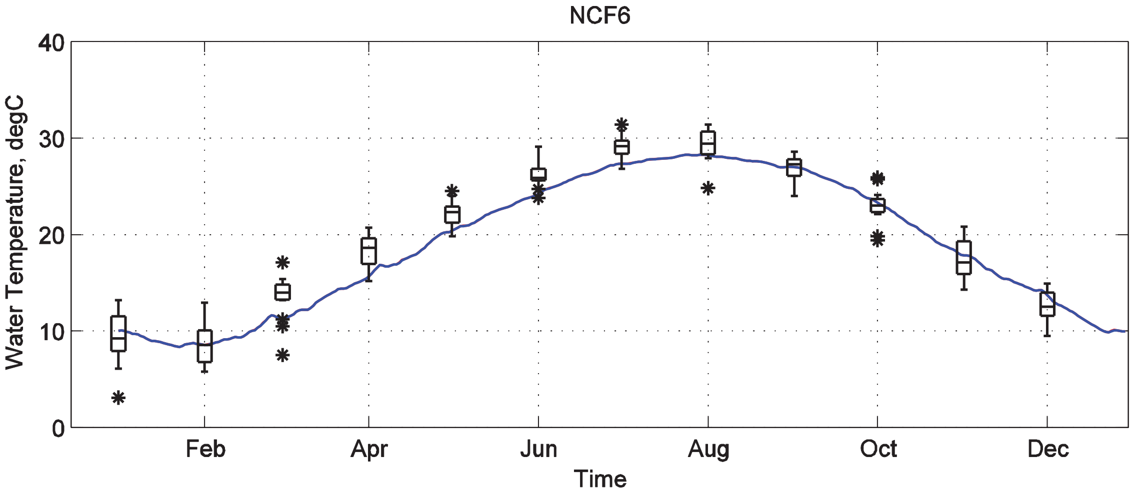

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TSS - LCFRP 2004-2017 Data
M61
M54
M35
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

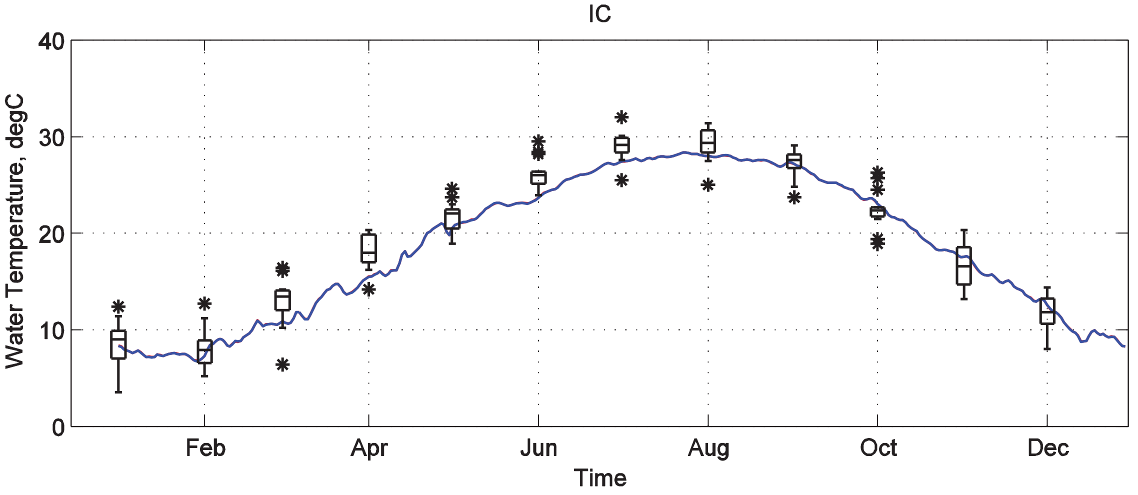

TSS - LCFRP 2004-2017 Data
M23
Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

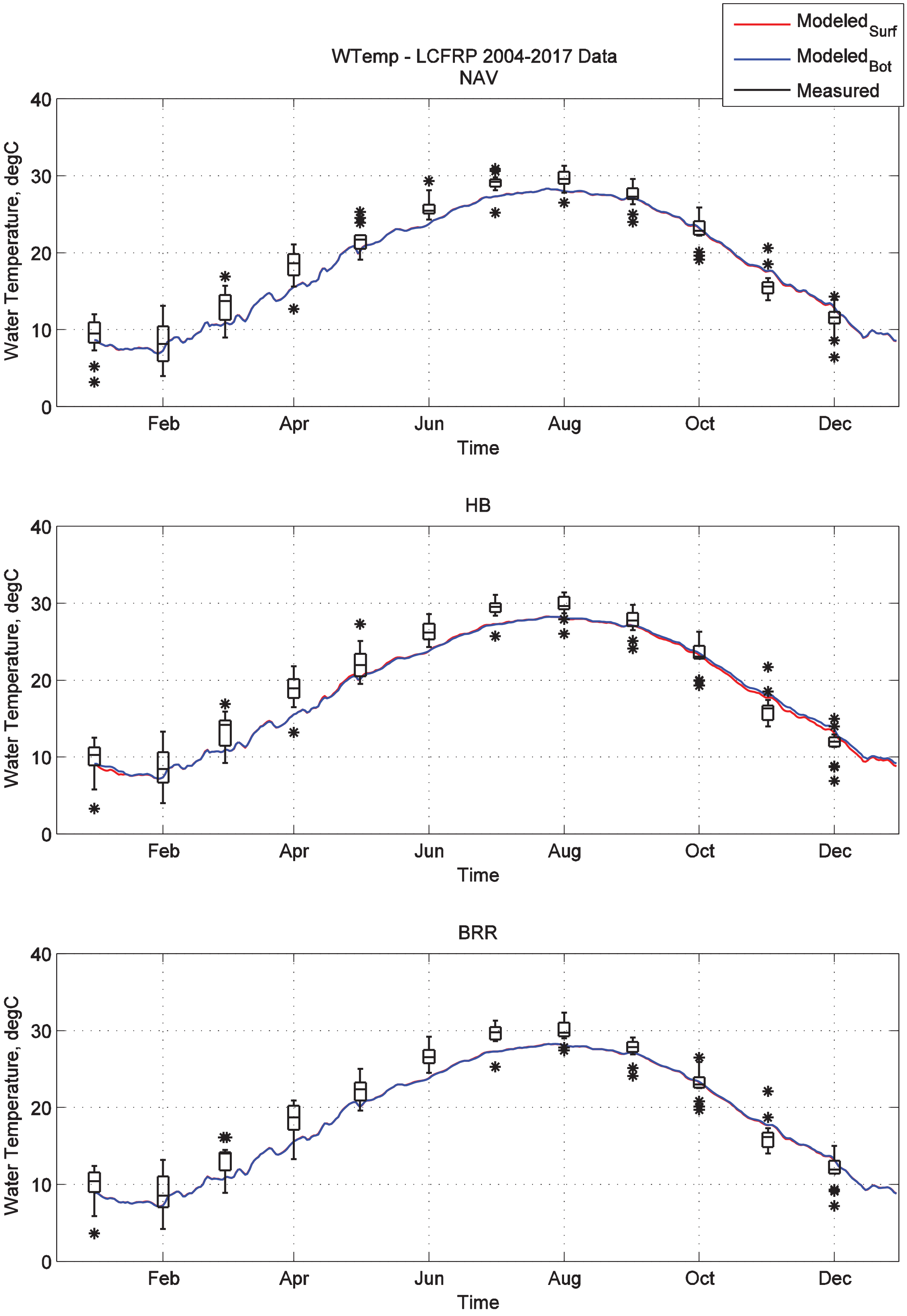

M18
TSS, mg/L
0
10
20
30
40
50
Feb
Apr
Jun
Aug
Oct
Dec
Time

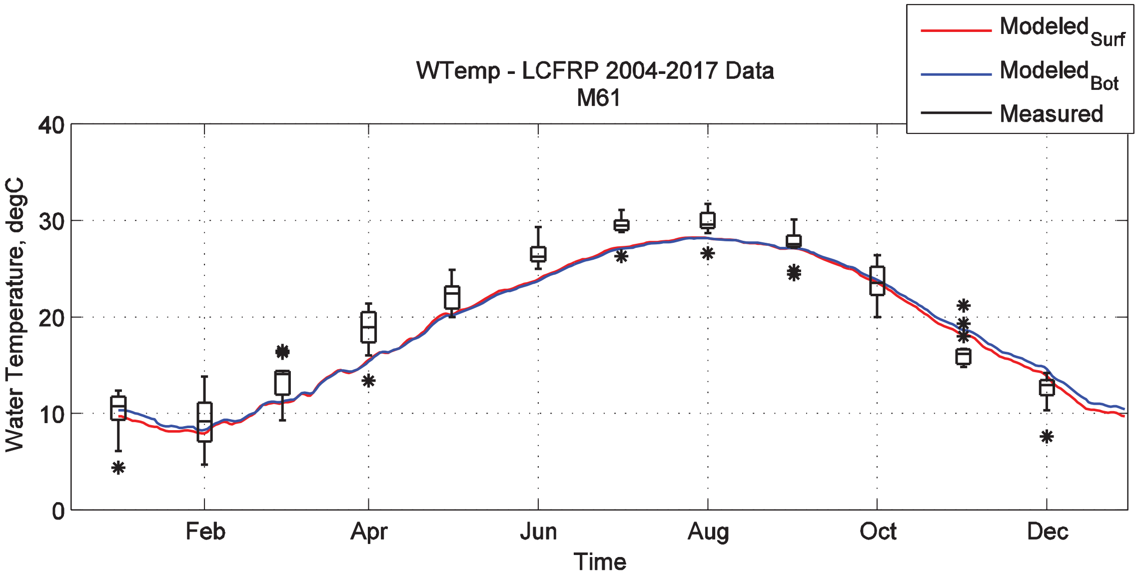

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
WTemp - LCFRP 2004-2017 Data
B210
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
NC11
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF117
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

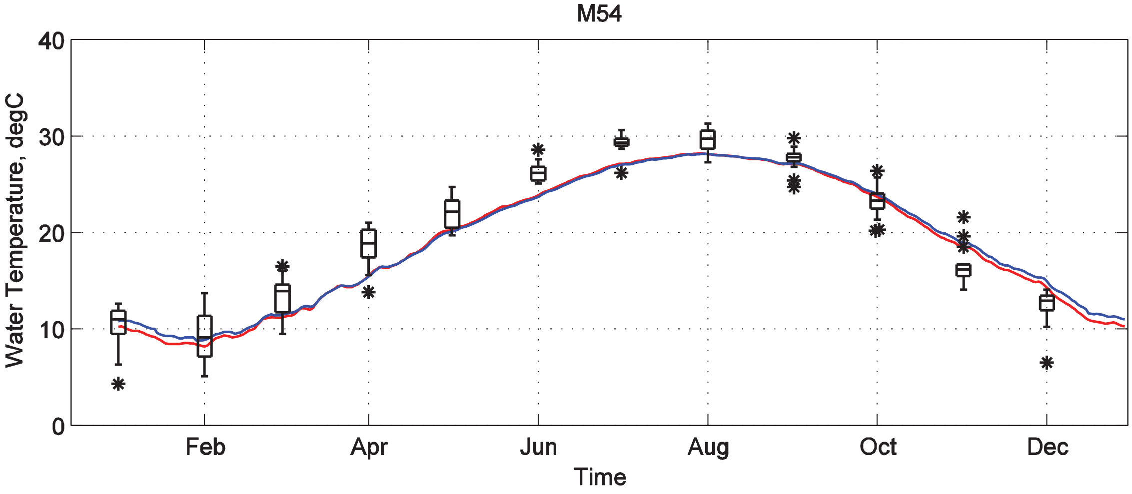

WTemp - LCFRP 2004-2017 Data
AC
Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

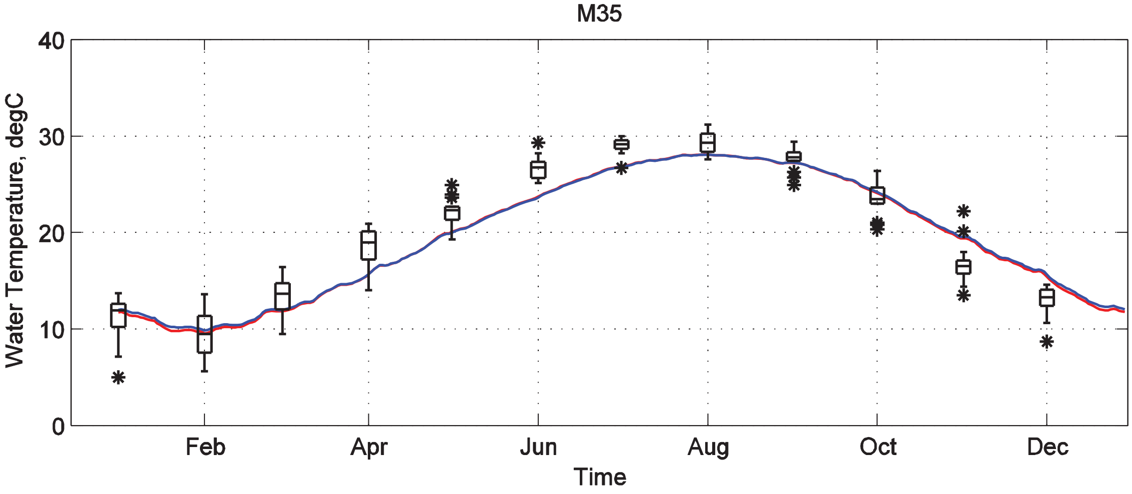

NCF6
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

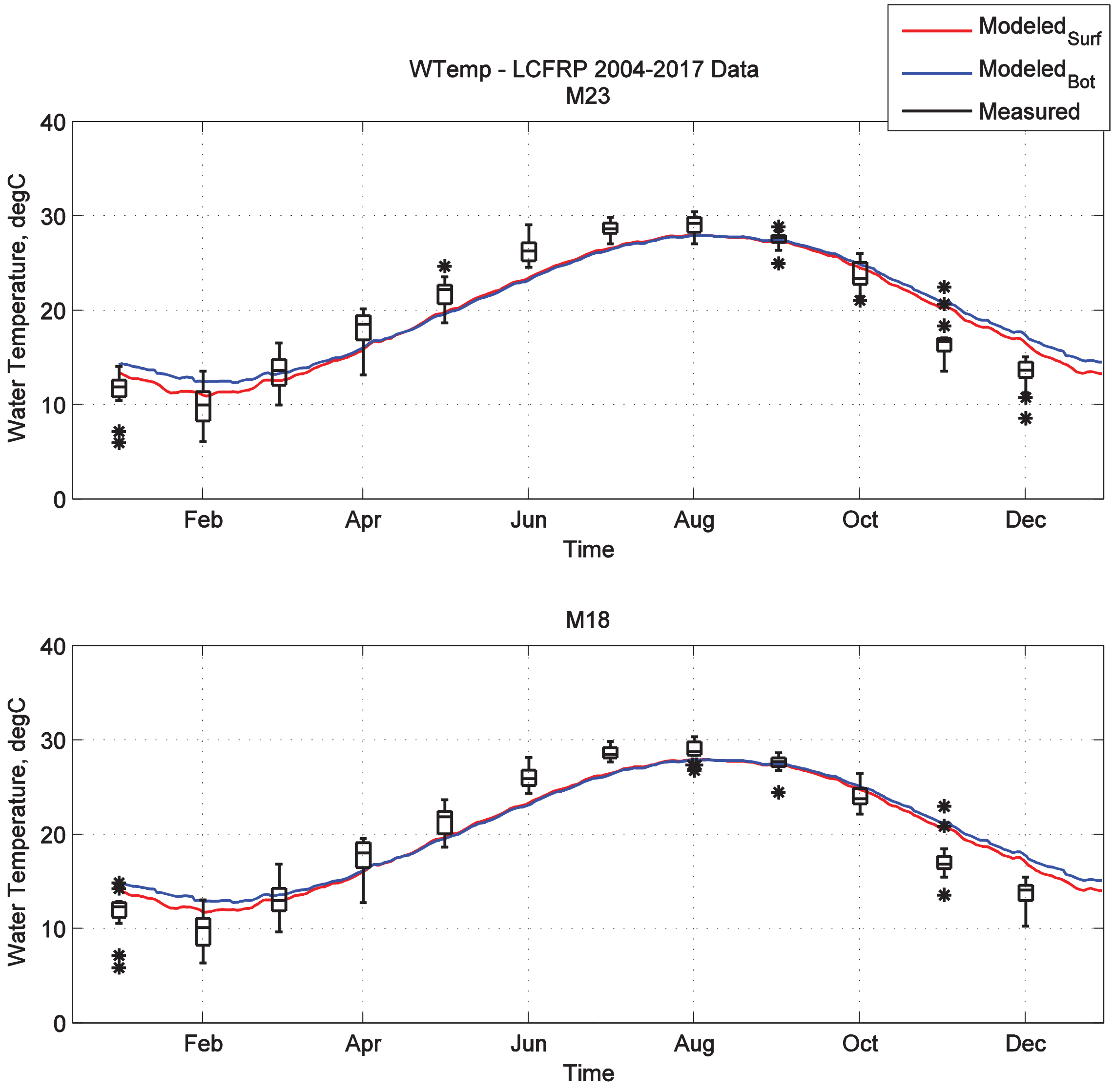

IC
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

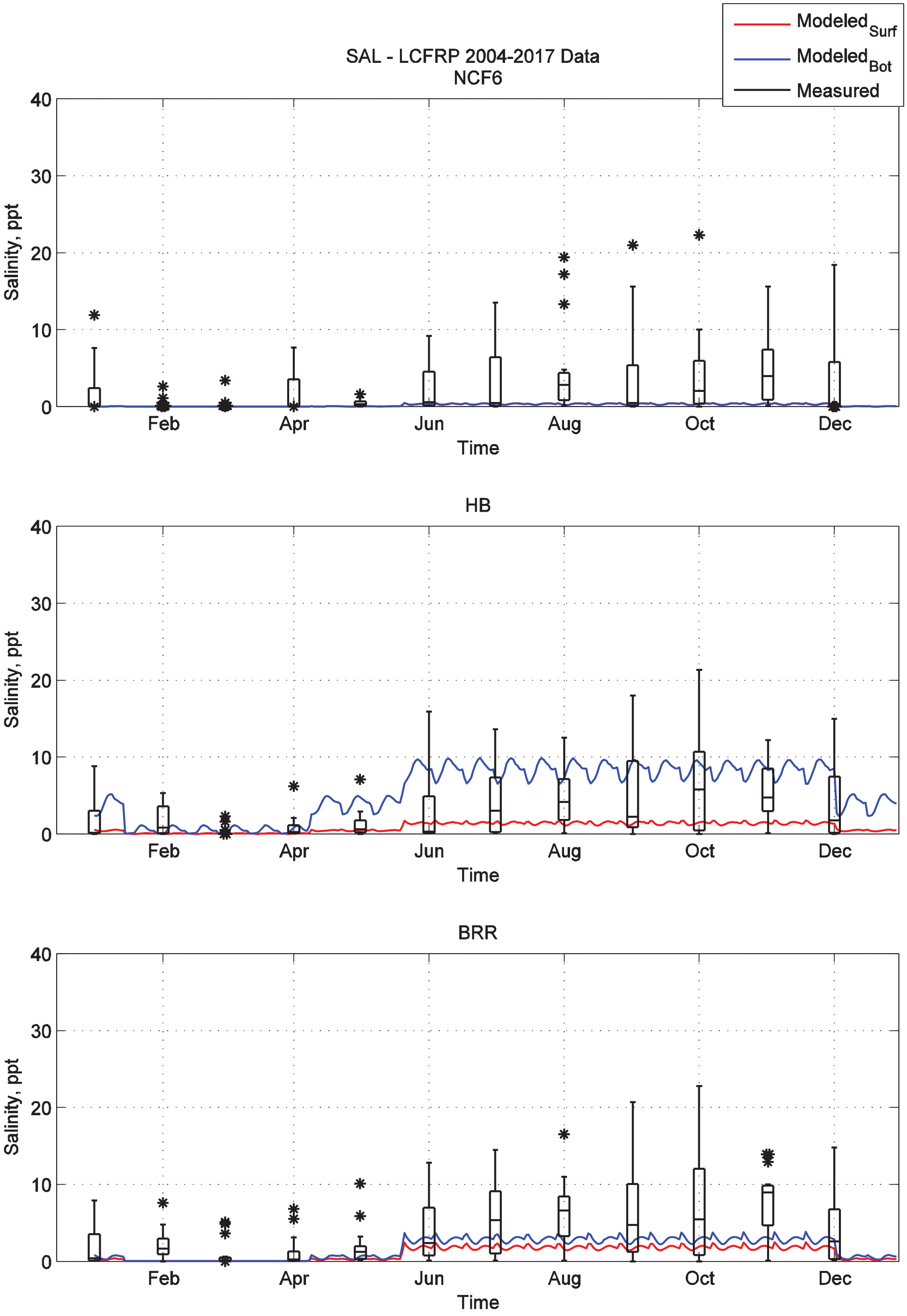

WTemp - LCFRP 2004-2017 Data
NAV
HB
BRR
Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
Water Temperature, degC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

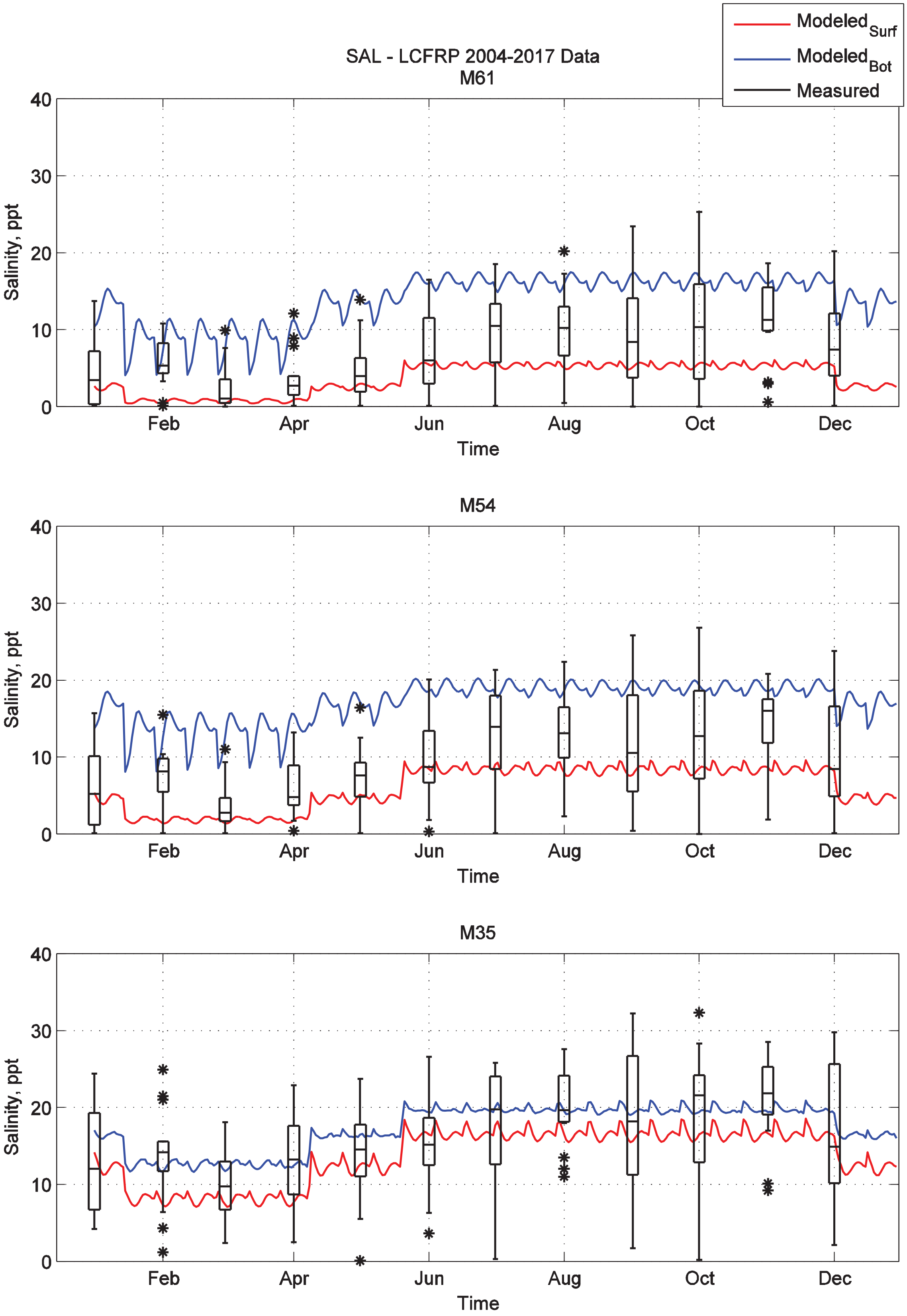

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
WTemp - LCFRP 2004-2017 Data
M61
Water Temperature, degC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

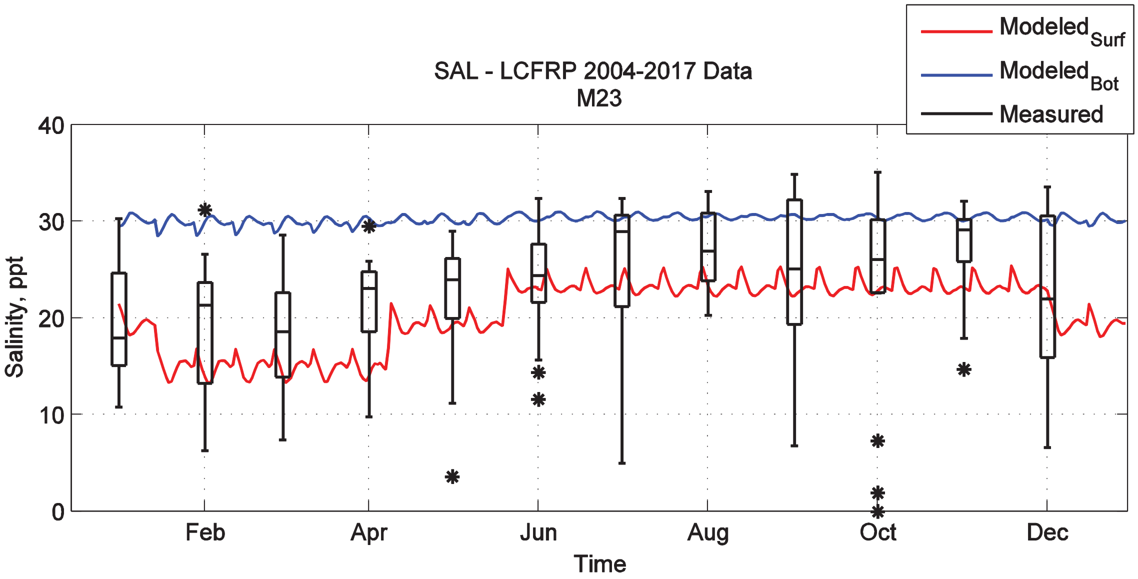

M54
Water Temperature, degC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

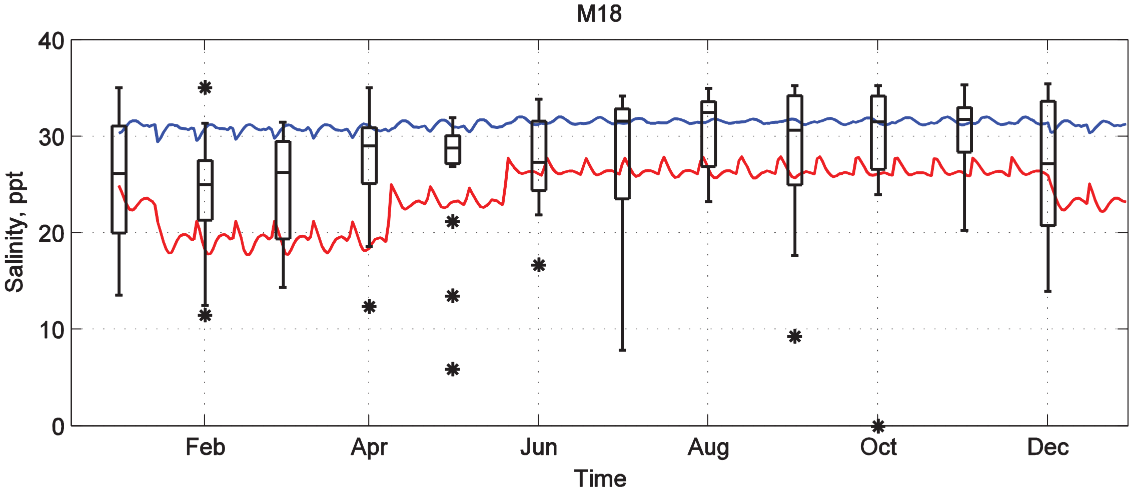

M35
Water Temperature, degC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
WTemp - LCFRP 2004-2017 Data
M23
Water Temperature, degC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
Water Temperature, degC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

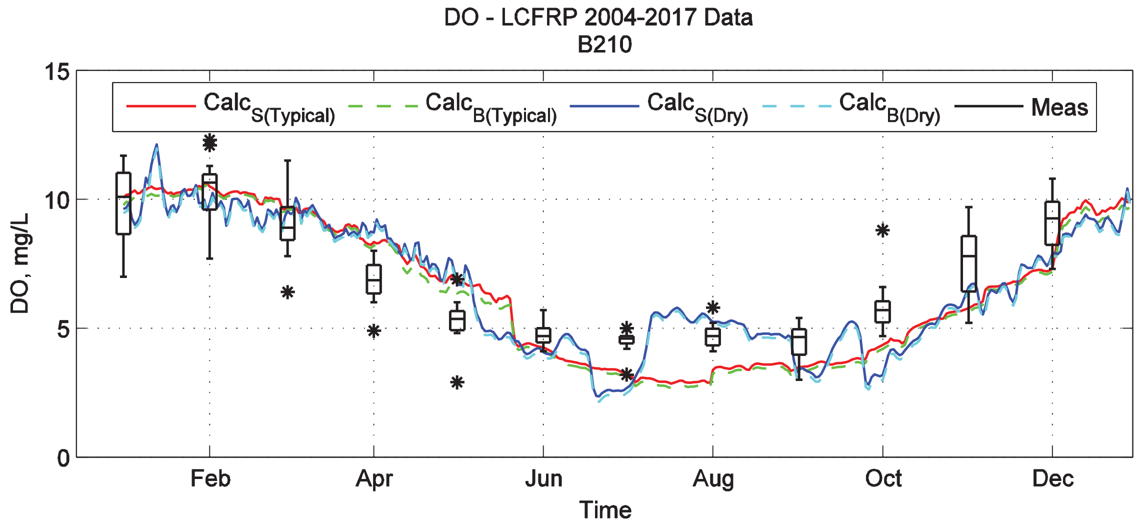

Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
SAL - LCFRP 2004-2017 Data
NCF6
HB
BRR
Salinity, ppt
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
SAL - LCFRP 2004-2017 Data
M61
Salinity, ppt
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M54
Salinity, ppt
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
M35
Salinity, ppt
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


Modeled$_{Surf}$
Modeled$_{Bot}$
Measured
SAL - LCFRP 2004-2017 Data
M23
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time


M18
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

Appendix C–4:
Plots of Modeled & Measured Water Quality Constituents for Sensitivity Test


DO - LCFRP 2004-2017 Data
B210
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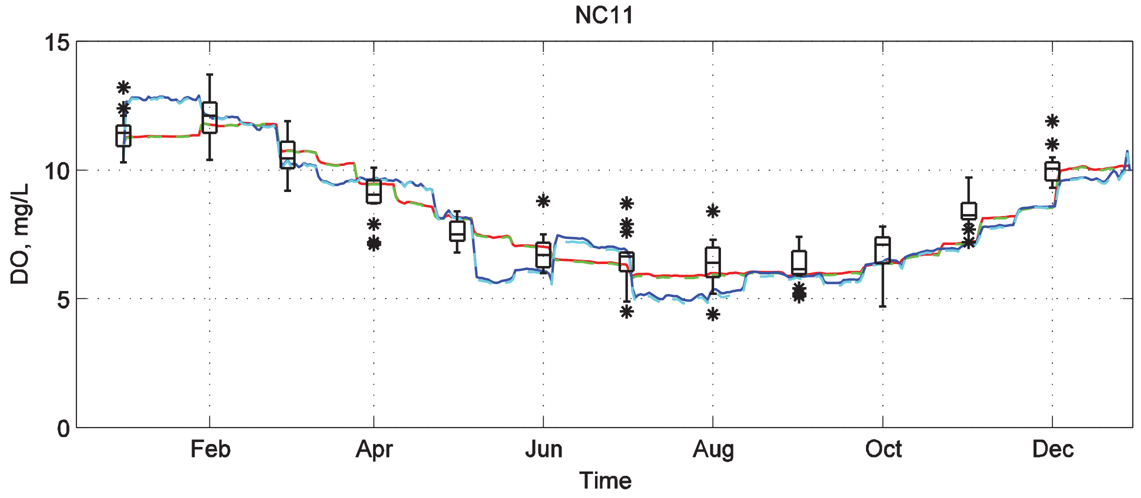
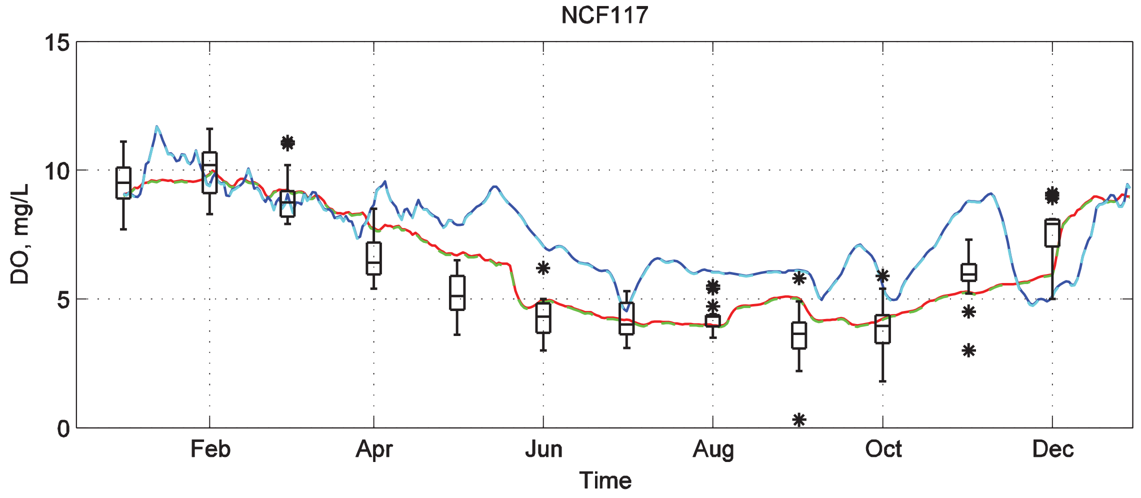
$\text{Calc}_{\text{B(Typical)}}$
$\text{Calc}_{\text{S(Dry)}}$
$\text{Calc}_{\text{B(Dry)}}$
Meas
DO, mg/L
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


NC11
DO, mg/L
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


NCF117
DO, mg/L
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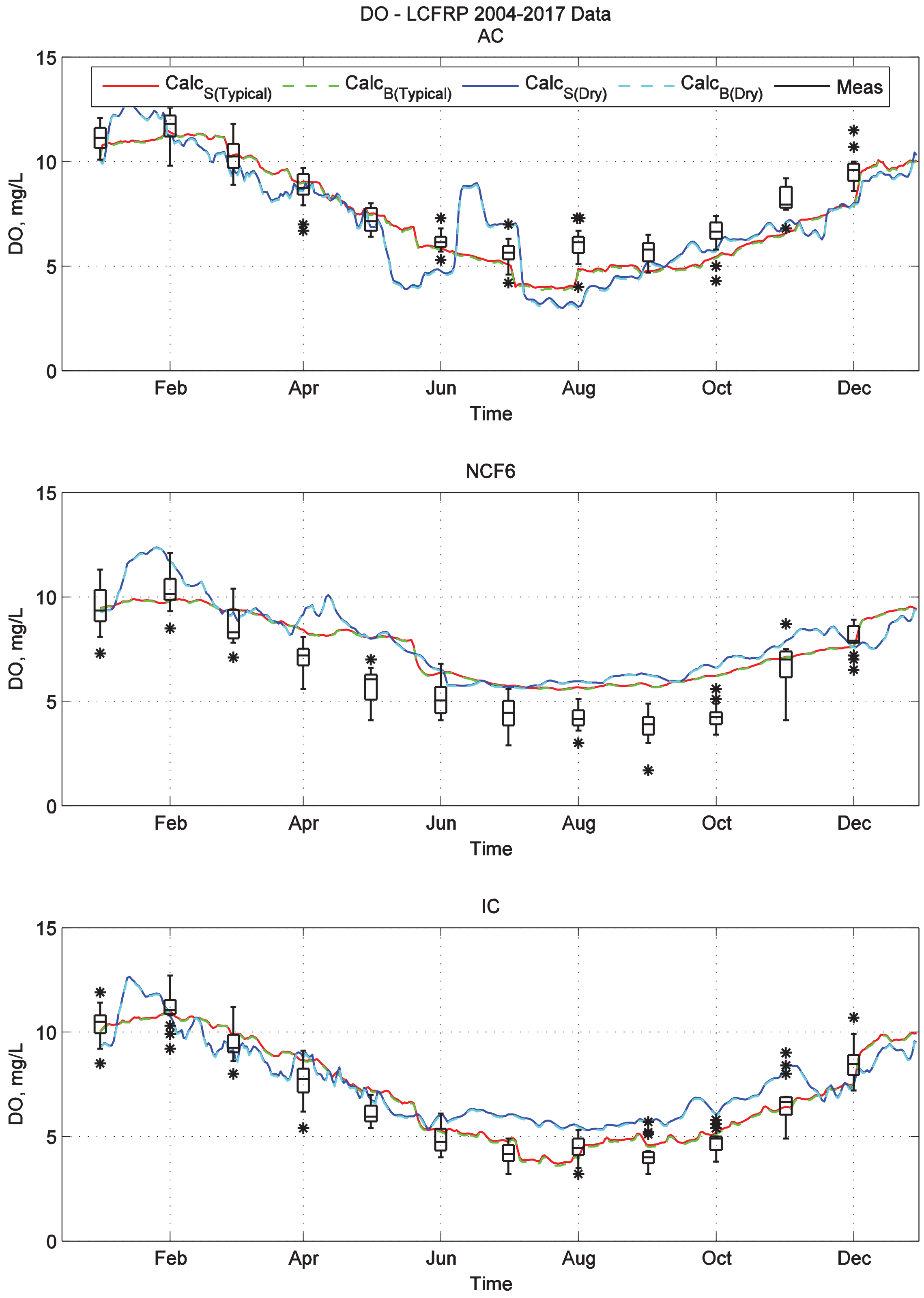
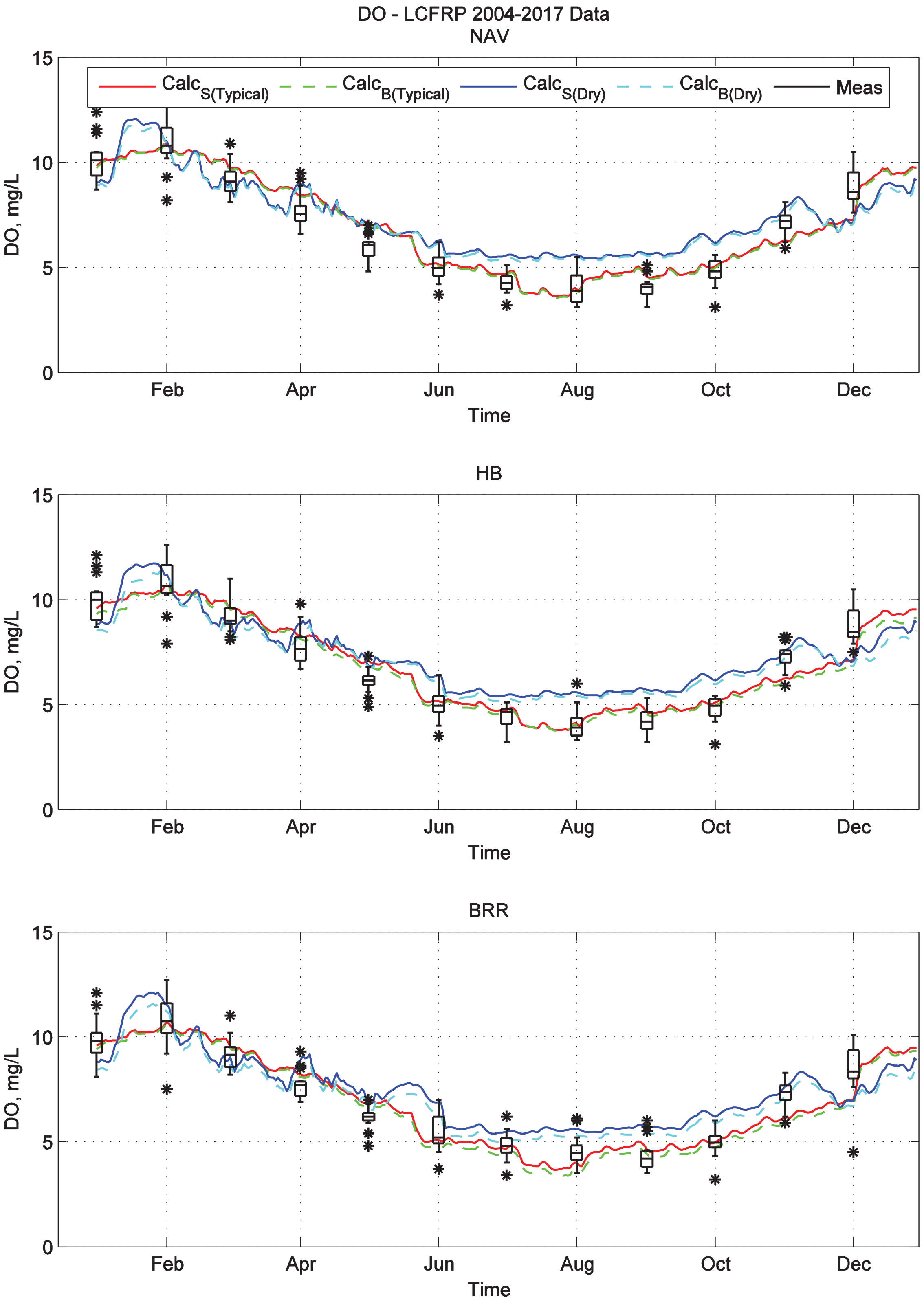
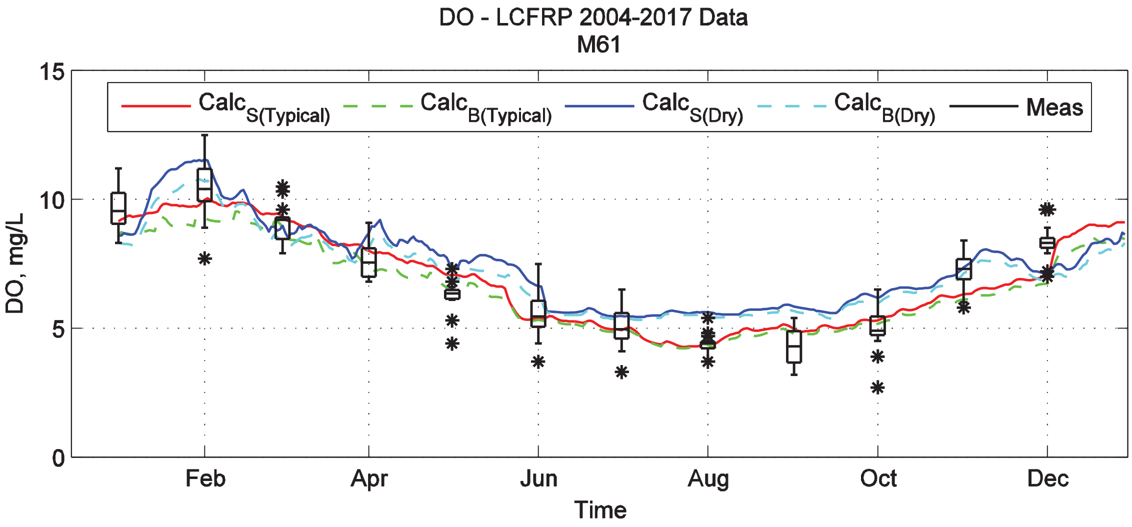
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


DO - LCFRP 2004-2017 Data
AC
Calc_S(Typical)
Calc_B(Typical)
Calc_S(Dry)
Calc_B(Dry)
Meas
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF6
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time
IC
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time


DO - LCFRP 2004-2017 Data
NAV
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time
HB
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time
BRR
DO, mg/L
0
5
10
15
Feb
Apr
Jun
Aug
Oct
Dec
Time


DO - LCFRP 2004-2017 Data
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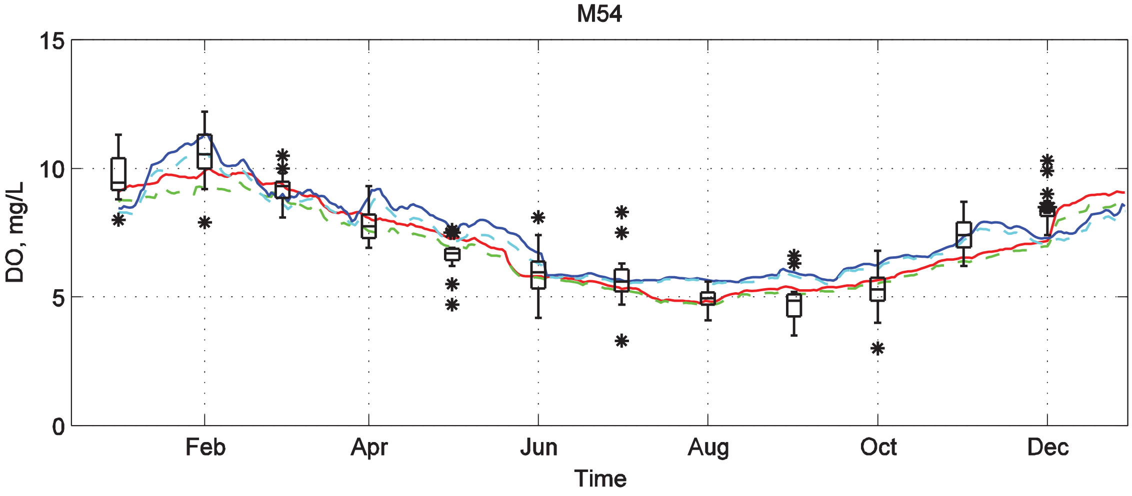
Calc B(Typical)
Calc S(Dry)
Calc B(Dry)
Meas
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time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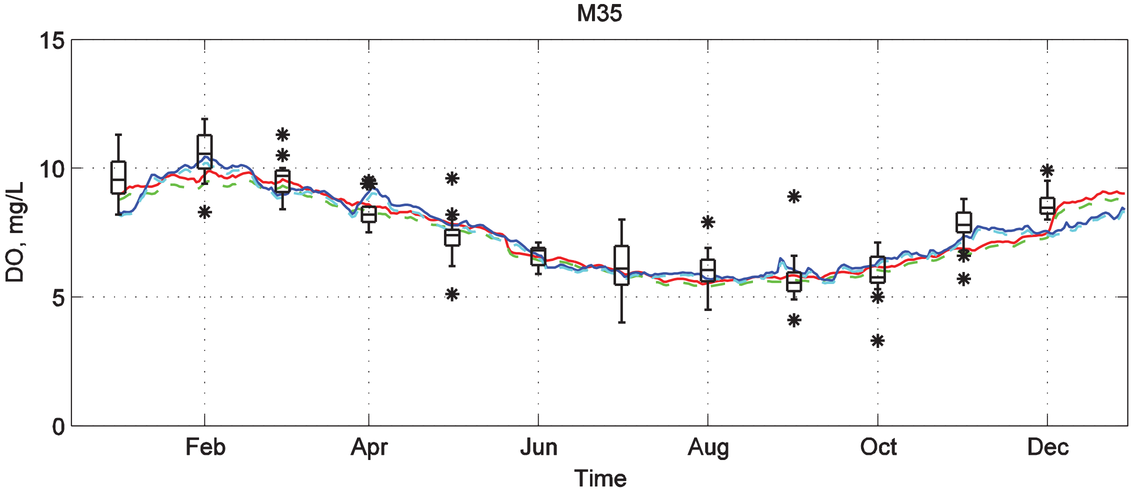
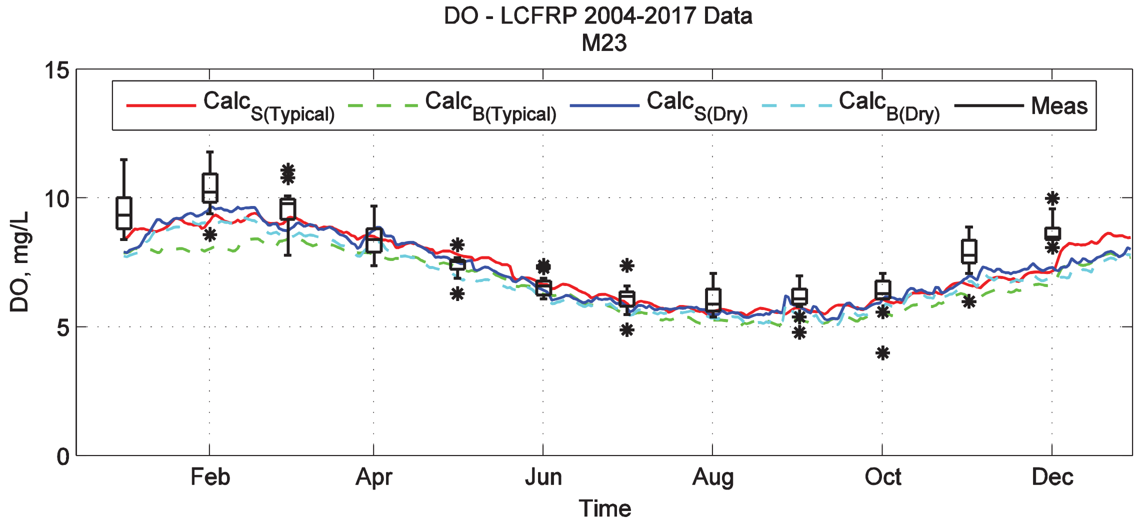
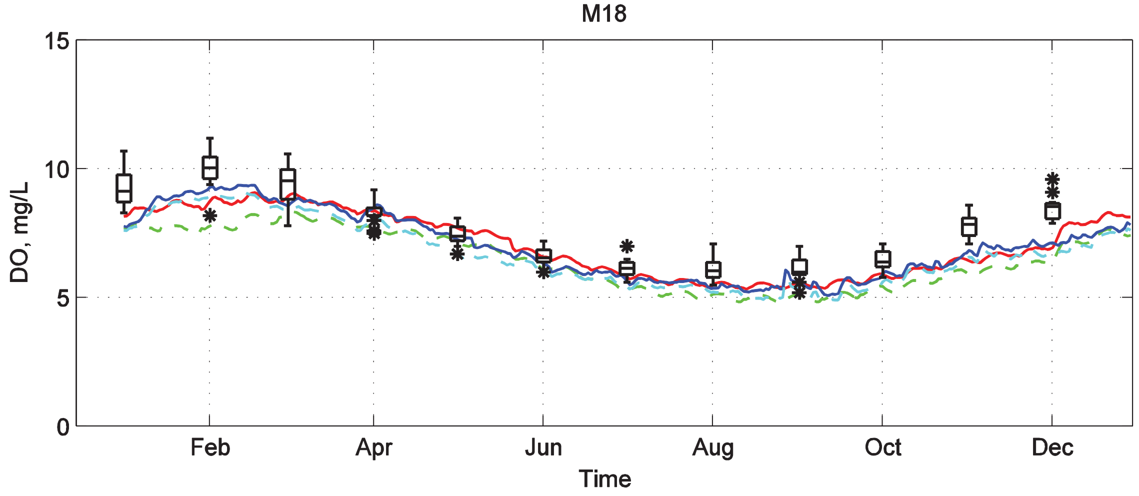
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time

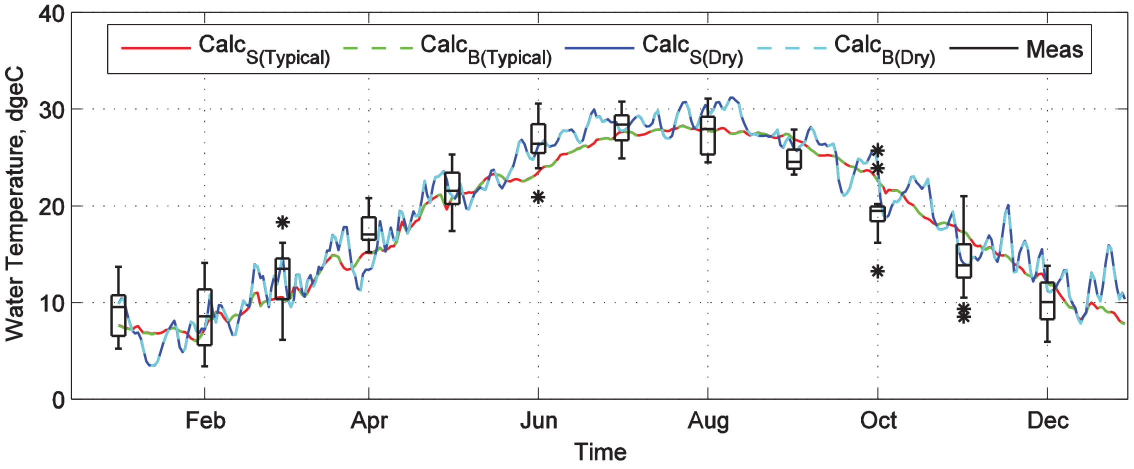

M35
15
10
5
0
DO, mg/L
Feb
Apr
Jun
Aug
Oct
Dec
Time


DO - LCFRP 2004-2017 Data
M23
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
DO, mg/L
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

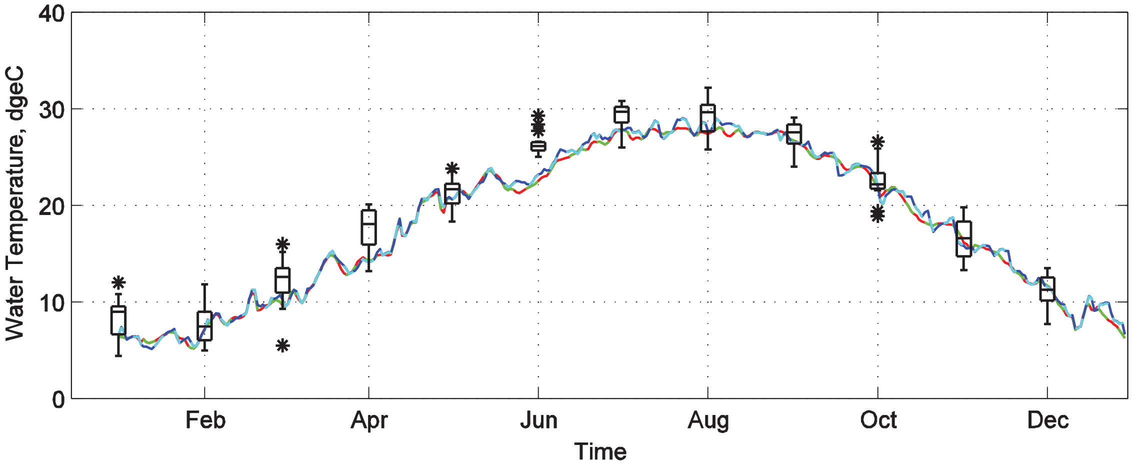

M18
DO, mg/L
15
10
5
0
Feb
Apr
Jun
Aug
Oct
Dec
Time

WTemp - LCFRP 2004-2017 Data

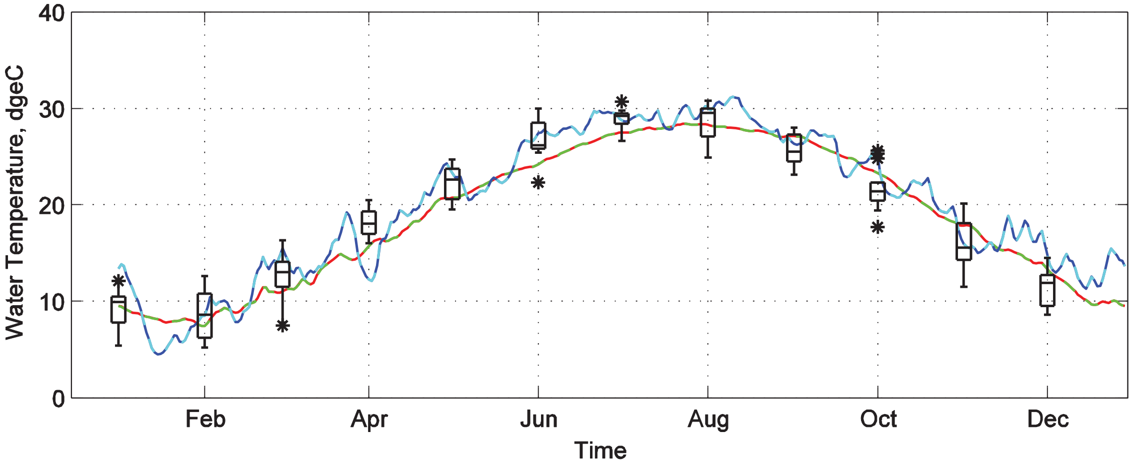
B210

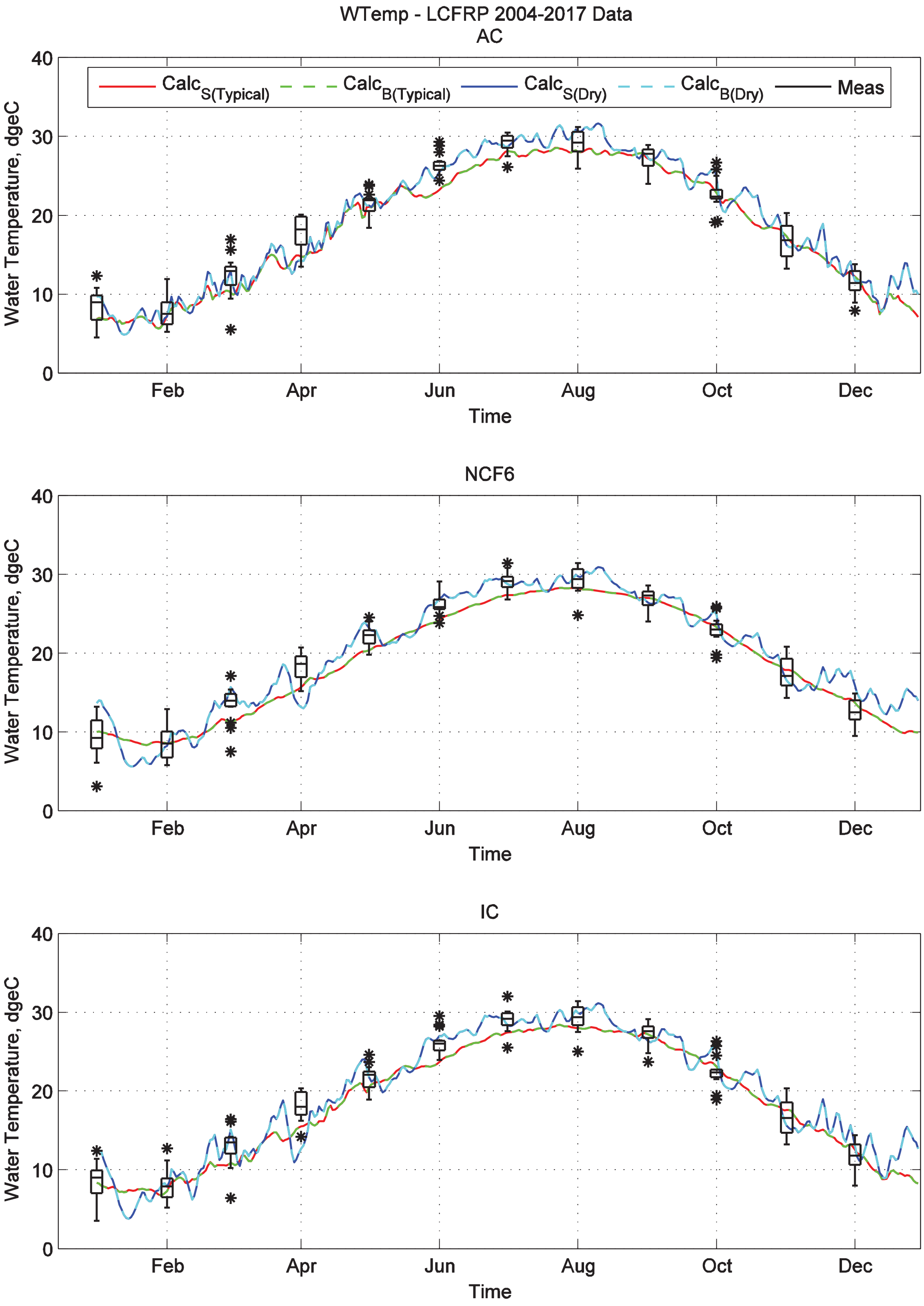


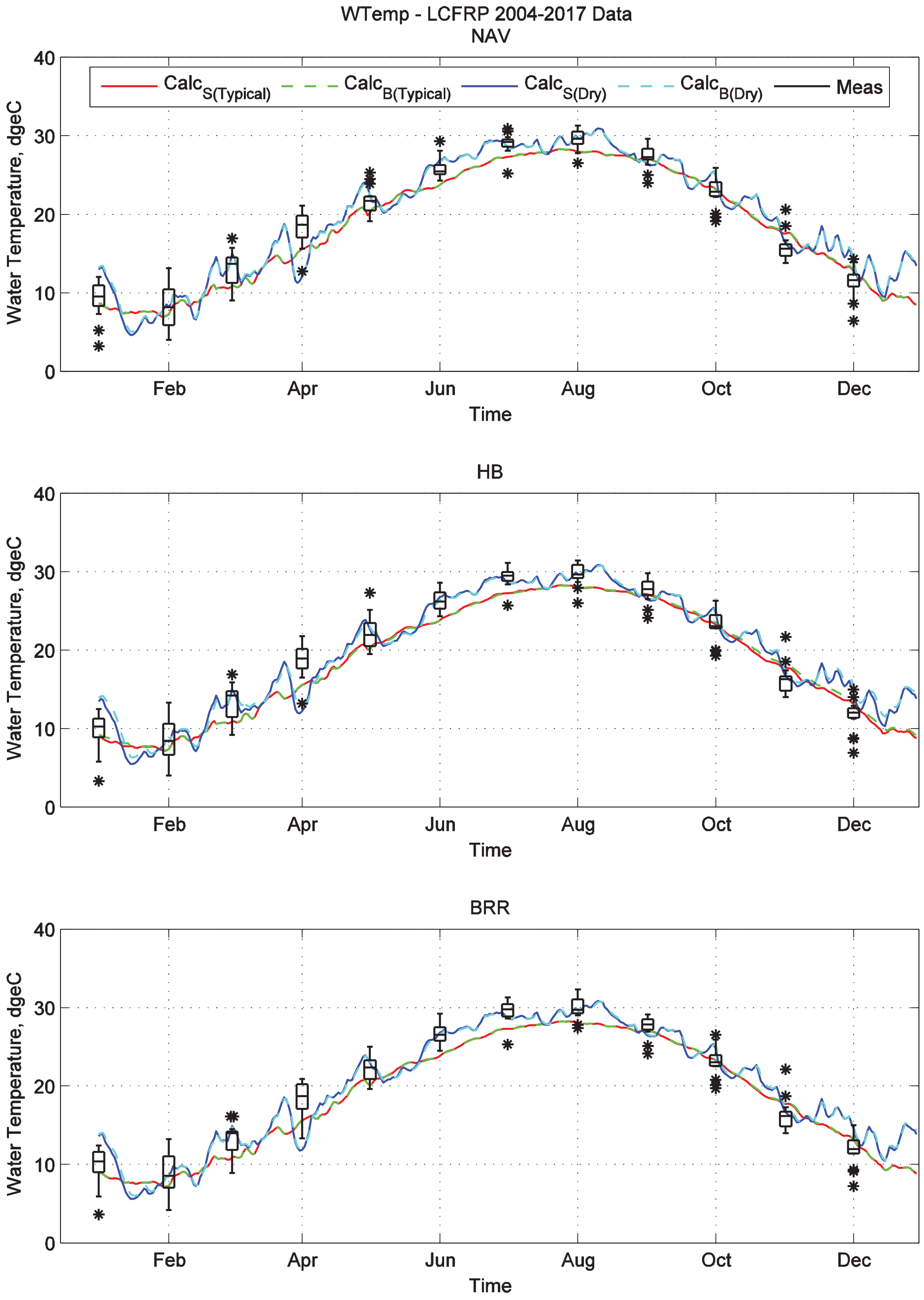
NC11

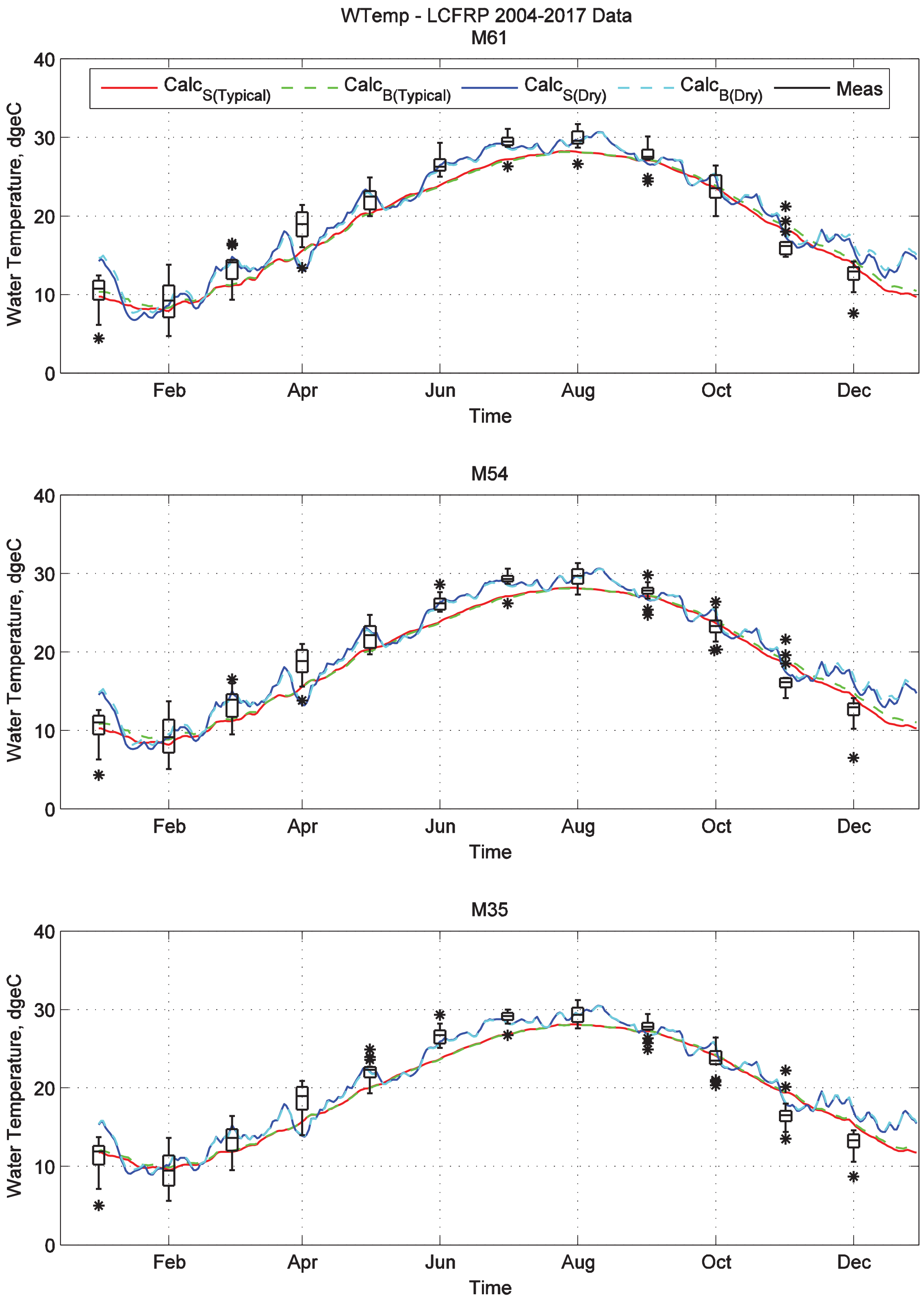


NCF117




WTemp - LCFRP 2004-2017 Data
AC
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
Water Temperature, dgeC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
NCF6
Water Temperature, dgeC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time
IC
Water Temperature, dgeC
40
30
20
10
0
Feb
Apr
Jun
Aug
Oct
Dec
Time


WTemp - LCFRP 2004-2017 Data
NAV
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
Water Temperature, dgeC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
HB
Water Temperature, dgeC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
BRR
Water Temperature, dgeC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

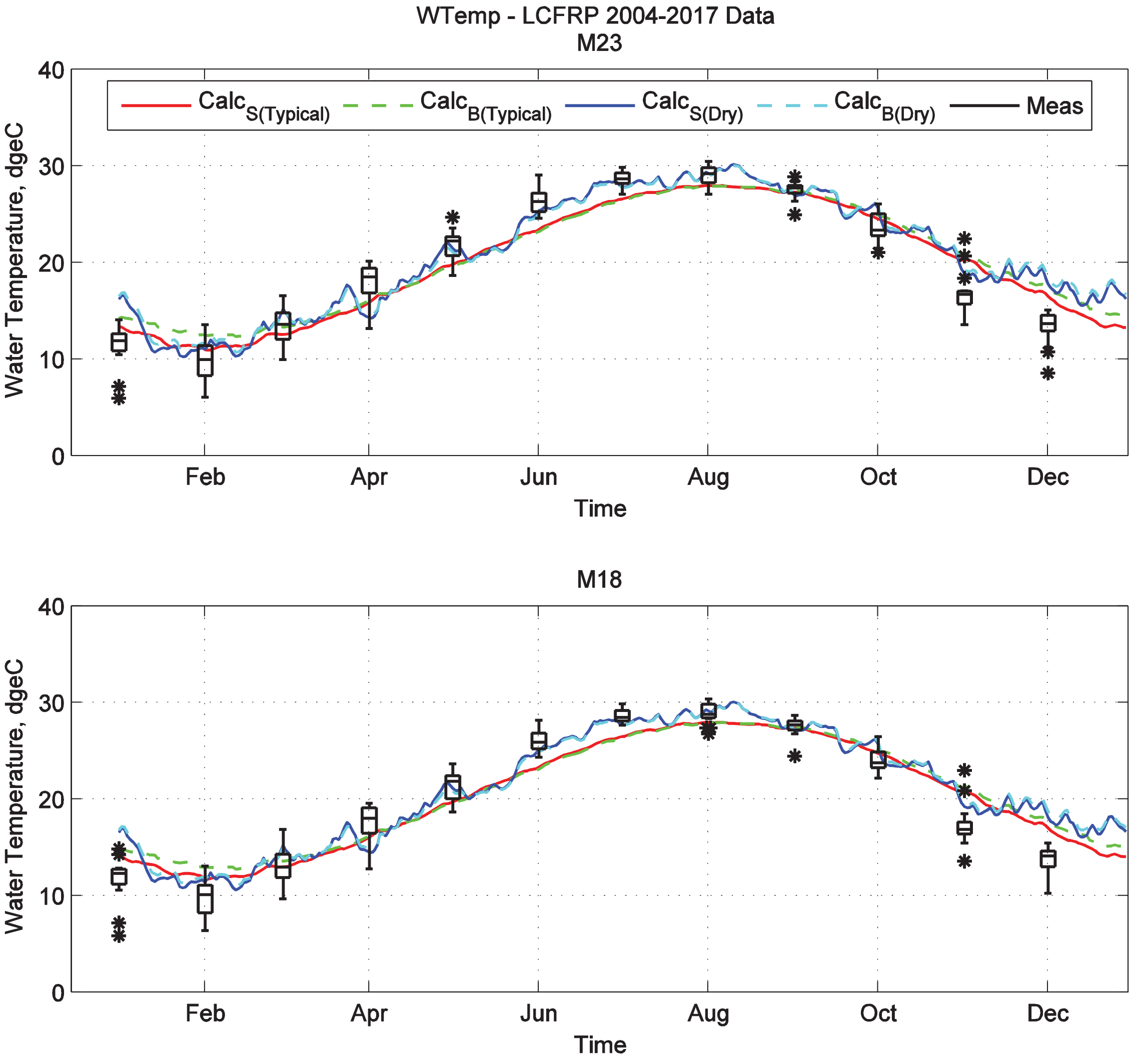


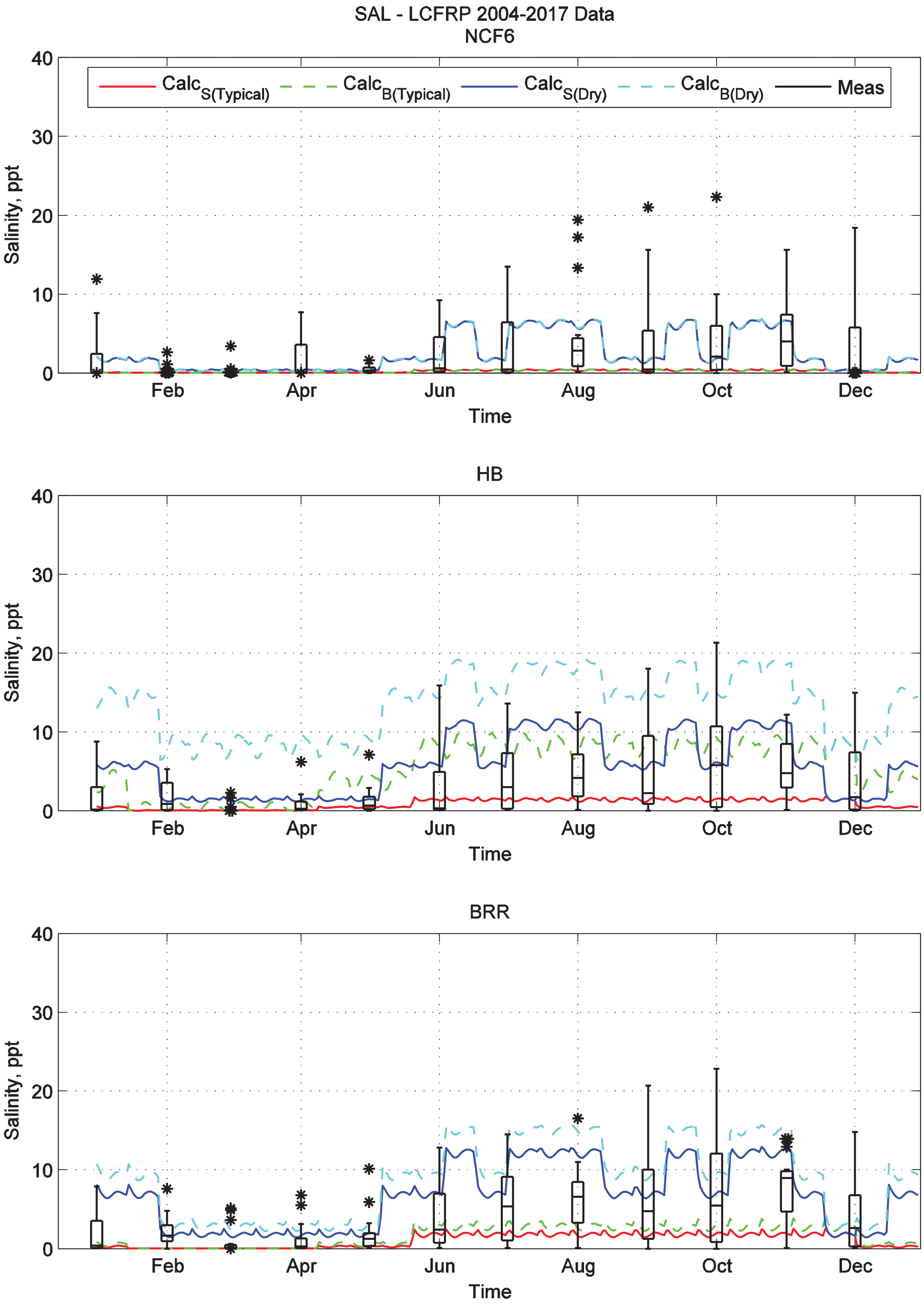
WTemp - LCFRP 2004-2017 Data

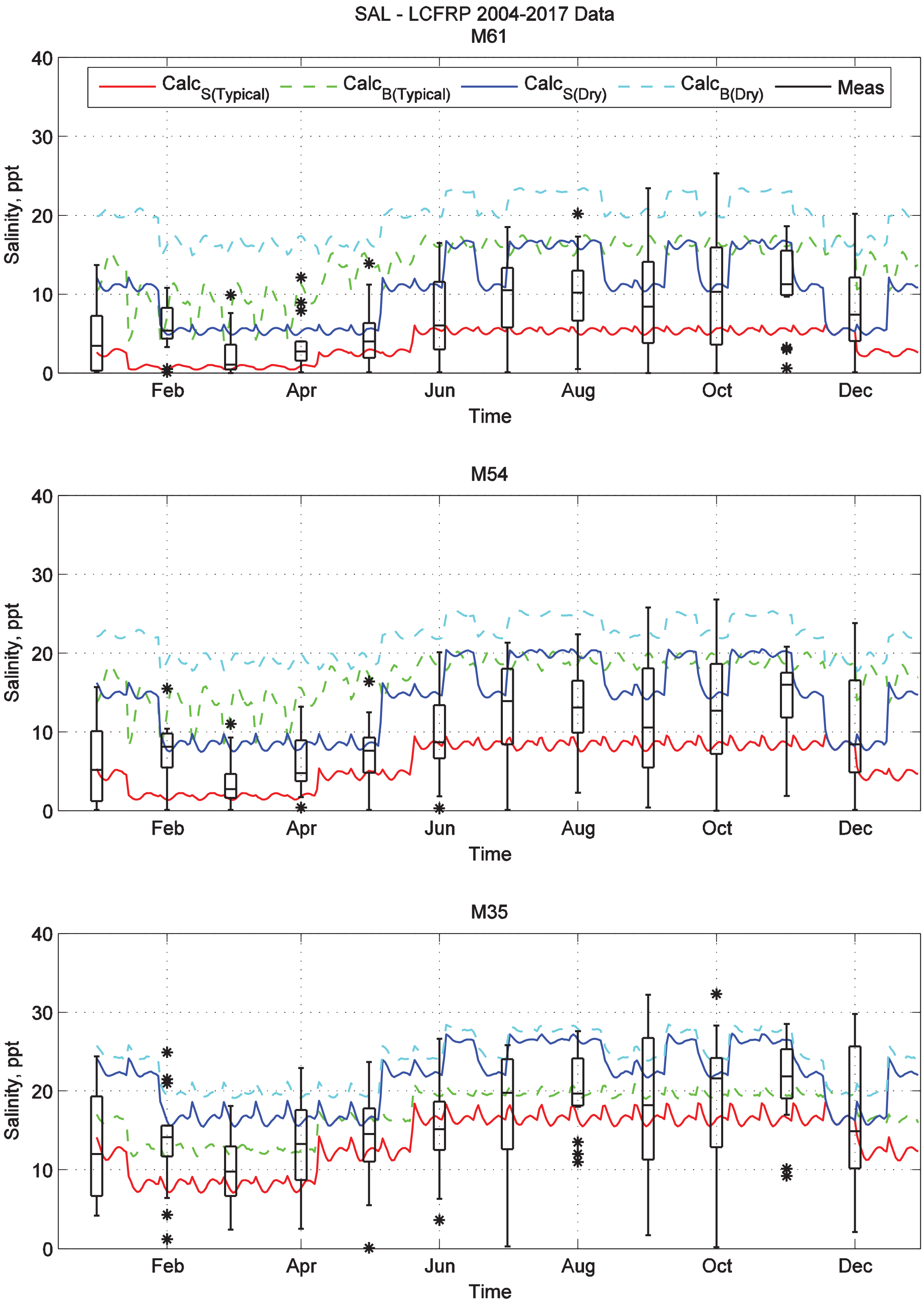
M61

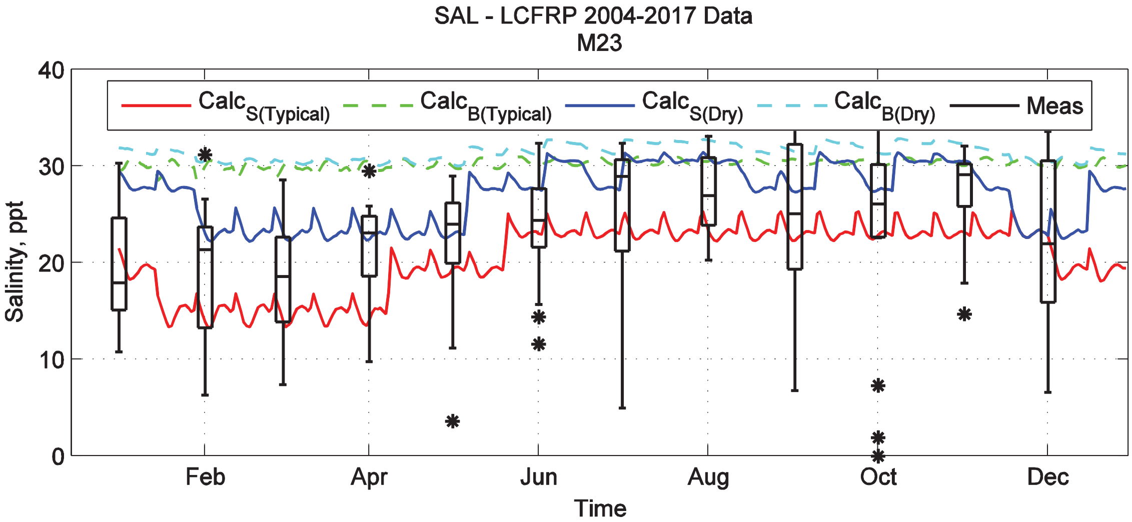
M54

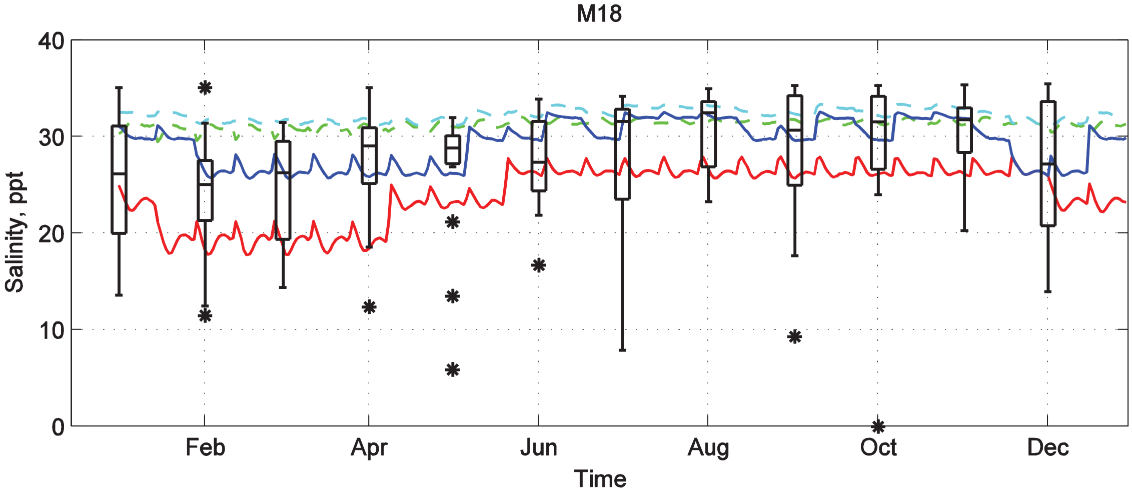
M35


WTemp - LCFRP 2004-2017 Data
M23
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
Water Temperature, dgeC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
M18
Water Temperature, dgeC
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time


SAL - LCFRP 2004-2017 Data
NCF6
Calc S(Typical)
Calc B(Typical)
Calc S(Dry)
Calc B(Dry)
Meas
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
HB
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
BRR
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time


SAL - LCFRP 2004-2017 Data
M61
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
M54
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time
M35
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time


SAL - LCFRP 2004-2017 Data
M23
Calc$_{S(Typical)}$
Calc$_{B(Typical)}$
Calc$_{S(Dry)}$
Calc$_{B(Dry)}$
Meas
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time


M18
Salinity, ppt
0
10
20
30
40
Feb
Apr
Jun
Aug
Oct
Dec
Time

Appendix D–1:
Water Levels

Water Level Comparison (ft) for RSLR Low Scenario with Low Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.24	0.24	0.00	-0.24	-0.23	0.00	0.47	0.47	0.00
NECF04	0.43	0.43	0.00	-0.46	-0.46	0.00	0.88	0.89	0.00
CFR04	0.68	0.68	0.00	-0.89	-0.88	0.00	1.57	1.56	-0.01
NECF03	1.31	1.34	0.03	-1.66	-1.70	-0.04	2.96	3.04	0.07
CFR03	0.81	0.81	0.00	-1.15	-1.15	0.00	1.96	1.96	0.00
NECF02	1.52	1.56	0.04	-1.83	-1.89	-0.06	3.35	3.44	0.10
CFR02	1.48	1.52	0.04	-2.02	-2.08	-0.06	3.50	3.60	0.11
CFR01	2.18	2.27	0.09	-2.79	-2.93	-0.14	4.97	5.20	0.23
NECF01	2.22	2.32	0.09	-2.79	-2.94	-0.15	5.02	5.25	0.24
Battleship	2.29	2.39	0.10	-2.86	-3.02	-0.16	5.15	5.41	0.26
LowerAnchorageBasin	2.30	2.41	0.11	-2.90	-3.06	-0.17	5.20	5.47	0.28
LowerBigIsland	2.25	2.34	0.09	-2.67	-2.82	-0.15	4.92	5.16	0.24
LowerLilliput	2.24	2.31	0.07	-2.48	-2.60	-0.12	4.72	4.90	0.19
LowerMidnight	2.23	2.30	0.07	-2.37	-2.46	-0.09	4.60	4.76	0.16
SnowMarsh	2.21	2.28	0.07	-2.23	-2.30	-0.07	4.44	4.57	0.14
BatteryIsland	2.23	2.25	0.02	-2.25	-2.27	-0.02	4.48	4.52	0.04
BaldheadShoalR1	2.28	2.29	0.01	-2.28	-2.28	-0.01	4.56	4.57	0.02
BaldheadShoalR3	2.29	2.29	0.00	-2.31	-2.32	-0.01	4.60	4.60	0.01

Water Level Comparison (ft) for RSLR Low Scenario with Medium Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.22	0.23	0.01	-0.21	-0.22	-0.01	0.43	0.44	0.01
NECF04	0.39	0.40	0.00	-0.42	-0.43	0.00	0.82	0.82	0.01
CFR04	0.44	0.43	0.00	-0.57	-0.56	0.01	1.01	0.99	-0.02
NECF03	1.26	1.29	0.03	-1.61	-1.64	-0.04	2.86	2.93	0.07
CFR03	0.65	0.65	0.00	-0.87	-0.86	0.01	1.52	1.51	-0.01
NECF02	1.47	1.52	0.04	-1.80	-1.85	-0.05	3.27	3.36	0.10
CFR02	1.41	1.45	0.04	-1.91	-1.97	-0.06	3.32	3.41	0.10
CFR01	2.16	2.25	0.09	-2.80	-2.94	-0.14	4.97	5.20	0.23
NECF01	2.21	2.30	0.09	-2.81	-2.95	-0.14	5.02	5.25	0.23
Battleship	2.28	2.38	0.11	-2.88	-3.03	-0.16	5.15	5.41	0.26
LowerAnchorageBasin	2.29	2.40	0.11	-2.90	-3.07	-0.17	5.19	5.47	0.28
LowerBigIsland	2.24	2.33	0.09	-2.68	-2.82	-0.15	4.92	5.16	0.24
LowerLilliput	2.23	2.30	0.07	-2.48	-2.60	-0.11	4.72	4.90	0.19
LowerMidnight	2.22	2.29	0.07	-2.37	-2.45	-0.09	4.59	4.74	0.15
SnowMarsh	2.20	2.27	0.07	-2.22	-2.29	-0.07	4.42	4.56	0.14
BatteryIsland	2.22	2.24	0.02	-2.24	-2.26	-0.02	4.46	4.51	0.04
BaldheadShoalR1	2.28	2.29	0.01	-2.27	-2.27	0.00	4.55	4.56	0.01
BaldheadShoalR3	2.29	2.29	0.00	-2.32	-2.32	0.00	4.60	4.60	0.00

Water Level Comparison (ft) for RSLR Low Scenario with High Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.18	0.19	0.01	-0.19	-0.20	-0.01	0.37	0.39	0.02
NECF04	0.35	0.35	0.01	-0.39	-0.40	0.00	0.74	0.75	0.01
CFR04	0.19	0.20	0.01	-0.21	-0.22	-0.01	0.41	0.42	0.01
NECF03	1.19	1.22	0.03	-1.52	-1.55	-0.03	2.71	2.77	0.06
CFR03	0.44	0.44	0.01	-0.49	-0.49	0.00	0.93	0.93	0.01
NECF02	1.41	1.45	0.04	-1.73	-1.77	-0.05	3.14	3.23	0.08
CFR02	1.29	1.32	0.03	-1.73	-1.79	-0.05	3.02	3.10	0.09
CFR01	2.15	2.23	0.08	-2.80	-2.94	-0.14	4.95	5.18	0.23
NECF01	2.20	2.29	0.09	-2.82	-2.97	-0.14	5.03	5.26	0.23
Battleship	2.27	2.38	0.10	-2.89	-3.05	-0.16	5.17	5.42	0.26
LowerAnchorageBasin	2.27	2.38	0.12	-2.88	-3.06	-0.18	5.15	5.44	0.29
LowerBigIsland	2.23	2.32	0.08	-2.68	-2.82	-0.14	4.91	5.14	0.23
LowerLilliput	2.22	2.29	0.07	-2.48	-2.60	-0.12	4.70	4.88	0.18
LowerMidnight	2.21	2.27	0.06	-2.35	-2.44	-0.09	4.56	4.71	0.15
SnowMarsh	2.19	2.25	0.07	-2.20	-2.27	-0.07	4.38	4.52	0.14
BatteryIsland	2.20	2.22	0.02	-2.22	-2.25	-0.04	4.42	4.47	0.05
BaldheadShoalR1	2.28	2.28	0.01	-2.25	-2.25	0.00	4.53	4.54	0.01
BaldheadShoalR3	2.29	2.29	0.00	-2.32	-2.32	0.00	4.60	4.61	0.01

Water Level Comparison (ft) for RSLR Intermediate Scenario with Low Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.24	0.24	0.01	-0.23	-0.24	-0.01	0.47	0.48	0.01
NECF04	0.39	0.39	0.01	-0.40	-0.41	0.00	0.79	0.80	0.01
CFR04	0.53	0.52	0.00	-0.67	-0.65	0.01	1.19	1.18	-0.02
NECF03	1.18	1.21	0.03	-1.50	-1.54	-0.04	2.68	2.75	0.07
CFR03	0.65	0.65	0.00	-0.88	-0.87	0.01	1.52	1.52	-0.01
NECF02	1.40	1.44	0.04	-1.71	-1.76	-0.05	3.11	3.20	0.09
CFR02	1.35	1.39	0.04	-1.85	-1.92	-0.06	3.20	3.30	0.11
CFR01	2.09	2.18	0.09	-2.70	-2.84	-0.14	4.79	5.03	0.23
NECF01	2.14	2.24	0.10	-2.71	-2.85	-0.15	4.85	5.09	0.24
Battleship	2.21	2.32	0.11	-2.79	-2.95	-0.16	5.00	5.26	0.27
LowerAnchorageBasin	2.23	2.34	0.11	-2.82	-2.99	-0.17	5.05	5.33	0.28
LowerBigIsland	2.18	2.27	0.09	-2.60	-2.75	-0.14	4.78	5.02	0.23
LowerLilliput	2.19	2.26	0.07	-2.42	-2.54	-0.11	4.62	4.80	0.18
LowerMidnight	2.21	2.27	0.06	-2.33	-2.41	-0.08	4.54	4.68	0.15
SnowMarsh	2.21	2.27	0.06	-2.20	-2.26	-0.06	4.41	4.53	0.12
BatteryIsland	2.24	2.26	0.01	-2.25	-2.27	-0.02	4.49	4.53	0.04
BaldheadShoalR1	2.28	2.30	0.01	-2.28	-2.28	0.00	4.56	4.57	0.01
BaldheadShoalR3	2.28	2.29	0.01	-2.31	-2.31	0.00	4.59	4.60	0.01

Water Level Comparison (ft) for RSLR Intermediate Scenario with Medium Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.24	0.25	0.01	-0.24	-0.25	-0.01	0.48	0.50	0.02
NECF04	0.36	0.37	0.01	-0.40	-0.40	-0.01	0.76	0.77	0.01
CFR04	0.33	0.33	0.00	-0.38	-0.37	0.00	0.70	0.70	0.00
NECF03	1.14	1.16	0.03	-1.44	-1.48	-0.04	2.58	2.64	0.06
CFR03	0.52	0.52	0.00	-0.62	-0.62	0.00	1.14	1.14	0.00
NECF02	1.36	1.40	0.04	-1.67	-1.72	-0.05	3.03	3.12	0.09
CFR02	1.28	1.31	0.04	-1.74	-1.80	-0.06	3.02	3.12	0.09
CFR01	2.08	2.17	0.09	-2.71	-2.86	-0.14	4.79	5.02	0.23
NECF01	2.13	2.22	0.09	-2.72	-2.86	-0.14	4.84	5.08	0.24
Battleship	2.20	2.31	0.11	-2.80	-2.95	-0.16	5.00	5.26	0.26
LowerAnchorageBasin	2.22	2.33	0.11	-2.82	-2.99	-0.17	5.04	5.33	0.28
LowerBigIsland	2.17	2.26	0.09	-2.60	-2.75	-0.14	4.78	5.01	0.23
LowerLilliput	2.19	2.25	0.06	-2.42	-2.54	-0.11	4.61	4.78	0.17
LowerMidnight	2.20	2.26	0.06	-2.32	-2.40	-0.08	4.52	4.66	0.14
SnowMarsh	2.20	2.26	0.06	-2.18	-2.25	-0.07	4.38	4.51	0.13
BatteryIsland	2.23	2.25	0.02	-2.23	-2.26	-0.03	4.46	4.51	0.04
BaldheadShoalR1	2.29	2.29	0.01	-2.27	-2.27	0.00	4.55	4.56	0.01
BaldheadShoalR3	2.28	2.29	0.00	-2.31	-2.31	0.00	4.59	4.60	0.00

Water Level Comparison (ft) for RSLR Intermediate Scenario with High Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.20	0.21	0.01	-0.22	-0.23	-0.01	0.42	0.44	0.02
NECF04	0.34	0.35	0.01	-0.39	-0.39	-0.01	0.73	0.74	0.01
CFR04	0.20	0.21	0.01	-0.22	-0.23	-0.01	0.42	0.43	0.02
NECF03	1.07	1.10	0.02	-1.35	-1.39	-0.03	2.43	2.48	0.06
CFR03	0.39	0.40	0.01	-0.41	-0.42	-0.01	0.80	0.82	0.02
NECF02	1.31	1.34	0.04	-1.60	-1.65	-0.05	2.91	2.99	0.08
CFR02	1.16	1.19	0.03	-1.55	-1.59	-0.05	2.71	2.78	0.08
CFR01	2.07	2.16	0.09	-2.70	-2.84	-0.14	4.77	5.00	0.23
NECF01	2.12	2.21	0.09	-2.72	-2.86	-0.14	4.84	5.07	0.24
Battleship	2.20	2.31	0.11	-2.80	-2.96	-0.16	5.00	5.26	0.26
LowerAnchorageBasin	2.20	2.32	0.12	-2.79	-2.97	-0.18	4.99	5.29	0.30
LowerBigIsland	2.15	2.24	0.09	-2.60	-2.74	-0.14	4.75	4.98	0.23
LowerLilliput	2.17	2.23	0.06	-2.42	-2.53	-0.11	4.58	4.75	0.17
LowerMidnight	2.18	2.24	0.06	-2.30	-2.38	-0.08	4.48	4.62	0.14
SnowMarsh	2.18	2.24	0.06	-2.16	-2.23	-0.07	4.34	4.47	0.13
BatteryIsland	2.21	2.23	0.01	-2.21	-2.24	-0.03	4.42	4.46	0.04
BaldheadShoalR1	2.28	2.29	0.01	-2.25	-2.25	0.00	4.53	4.54	0.01
BaldheadShoalR3	2.29	2.29	0.00	-2.31	-2.31	0.00	4.60	4.60	0.00

Water Level Comparison (ft) for RSLR High Scenario with Low Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.30	0.31	0.01	-0.33	-0.34	-0.01	0.63	0.64	0.02
NECF04	0.38	0.39	0.01	-0.42	-0.43	-0.01	0.81	0.83	0.02
CFR04	0.33	0.34	0.01	-0.36	-0.37	-0.01	0.68	0.70	0.02
NECF03	0.81	0.84	0.03	-0.95	-0.98	-0.03	1.76	1.82	0.06
CFR03	0.42	0.43	0.01	-0.48	-0.49	-0.01	0.90	0.92	0.03
NECF02	1.04	1.08	0.04	-1.20	-1.25	-0.05	2.24	2.33	0.09
CFR02	1.00	1.04	0.04	-1.17	-1.22	-0.05	2.17	2.25	0.09
CFR01	1.87	1.97	0.10	-2.28	-2.42	-0.14	4.15	4.39	0.24
NECF01	1.92	2.03	0.11	-2.29	-2.44	-0.15	4.21	4.47	0.26
Battleship	2.03	2.15	0.12	-2.41	-2.57	-0.17	4.43	4.72	0.29
LowerAnchorageBasin	2.07	2.19	0.13	-2.45	-2.62	-0.17	4.51	4.81	0.30
LowerBigIsland	2.02	2.11	0.09	-2.30	-2.43	-0.13	4.32	4.55	0.23
LowerLilliput	2.06	2.12	0.06	-2.20	-2.29	-0.09	4.27	4.42	0.15
LowerMidnight	2.13	2.17	0.05	-2.18	-2.24	-0.06	4.31	4.41	0.11
SnowMarsh	2.18	2.22	0.04	-2.13	-2.17	-0.04	4.31	4.40	0.08
BatteryIsland	2.26	2.27	0.01	-2.22	-2.23	-0.02	4.47	4.50	0.03
BaldheadShoalR1	2.32	2.32	0.00	-2.27	-2.27	0.00	4.59	4.59	0.00
BaldheadShoalR3	2.27	2.28	0.00	-2.30	-2.30	0.00	4.57	4.58	0.00

Water Level Comparison (ft) for RSLR High Scenario with Medium Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.29	0.30	0.01	-0.32	-0.33	-0.01	0.60	0.62	0.02
NECF04	0.38	0.39	0.01	-0.43	-0.44	-0.01	0.81	0.83	0.02
CFR04	0.29	0.30	0.01	-0.33	-0.33	-0.01	0.62	0.63	0.02
NECF03	0.80	0.82	0.03	-0.91	-0.94	-0.03	1.71	1.77	0.06
CFR03	0.40	0.41	0.01	-0.45	-0.46	-0.01	0.85	0.87	0.02
NECF02	1.01	1.06	0.04	-1.16	-1.21	-0.05	2.18	2.27	0.09
CFR02	0.95	0.98	0.04	-1.09	-1.13	-0.04	2.04	2.11	0.08
CFR01	1.86	1.95	0.10	-2.28	-2.43	-0.15	4.13	4.38	0.24
NECF01	1.91	2.01	0.10	-2.27	-2.42	-0.15	4.18	4.43	0.26
Battleship	2.02	2.14	0.12	-2.40	-2.57	-0.17	4.42	4.71	0.29
LowerAnchorageBasin	2.06	2.18	0.12	-2.44	-2.61	-0.18	4.50	4.80	0.30
LowerBigIsland	2.01	2.11	0.10	-2.29	-2.42	-0.13	4.30	4.53	0.23
LowerLilliput	2.05	2.11	0.06	-2.19	-2.28	-0.09	4.25	4.39	0.15
LowerMidnight	2.11	2.15	0.04	-2.17	-2.23	-0.06	4.28	4.38	0.10
SnowMarsh	2.17	2.21	0.04	-2.12	-2.16	-0.04	4.29	4.37	0.08
BatteryIsland	2.24	2.25	0.01	-2.21	-2.23	-0.02	4.45	4.47	0.03
BaldheadShoalR1	2.30	2.30	0.00	-2.26	-2.26	-0.01	4.56	4.56	0.00
BaldheadShoalR3	2.28	2.28	0.00	-2.30	-2.30	0.00	4.58	4.58	0.00

Water Level Comparison (ft) for RSLR High Scenario with High Flow

Station	MHW			MLW			Range		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.26	0.27	0.01	-0.29	-0.30	-0.01	0.54	0.56	0.02
NECF04	0.38	0.39	0.01	-0.43	-0.44	-0.01	0.81	0.83	0.02
CFR04	0.25	0.25	0.01	-0.28	-0.29	-0.01	0.53	0.54	0.02
NECF03	0.77	0.80	0.03	-0.86	-0.89	-0.03	1.63	1.69	0.05
CFR03	0.36	0.37	0.01	-0.40	-0.41	-0.01	0.76	0.78	0.02
NECF02	0.98	1.02	0.04	-1.11	-1.15	-0.04	2.09	2.17	0.08
CFR02	0.89	0.92	0.03	-0.99	-1.02	-0.04	1.88	1.94	0.06
CFR01	1.84	1.93	0.09	-2.26	-2.41	-0.15	4.10	4.34	0.24
NECF01	1.89	1.99	0.10	-2.25	-2.40	-0.15	4.14	4.39	0.25
Battleship	2.02	2.13	0.11	-2.38	-2.56	-0.17	4.40	4.68	0.29
LowerAnchorageBasin	2.05	2.17	0.13	-2.40	-2.59	-0.19	4.45	4.76	0.31
LowerBigIsland	2.01	2.10	0.09	-2.27	-2.41	-0.13	4.28	4.51	0.22
LowerLilliput	2.04	2.09	0.06	-2.18	-2.27	-0.09	4.22	4.36	0.14
LowerMidnight	2.09	2.13	0.04	-2.15	-2.21	-0.06	4.24	4.34	0.10
SnowMarsh	2.14	2.18	0.04	-2.10	-2.15	-0.05	4.24	4.33	0.09
BatteryIsland	2.22	2.22	0.00	-2.19	-2.20	-0.01	4.41	4.42	0.01
BaldheadShoalR1	2.30	2.30	0.00	-2.24	-2.24	-0.01	4.54	4.54	0.01
BaldheadShoalR3	2.28	2.28	0.00	-2.30	-2.30	0.00	4.58	4.58	0.00

Appendix D–2:
Current Speeds

Current speed (ft/s) percentile at surface layer for RSLR Low projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.38	0.38	0.00	0.54	0.53	-0.01	0.61	0.59	-0.01	0.64	0.63	-0.01	0.71	0.70	-0.02
NECF04	1.16	1.18	0.01	1.41	1.43	0.02	1.53	1.55	0.02	1.56	1.58	0.02	1.62	1.63	0.01
CFR04	1.05	1.02	-0.03	1.64	1.64	0.00	1.86	1.86	0.01	1.90	1.90	0.01	1.94	1.95	0.01
NECF03	0.97	0.98	0.01	1.26	1.29	0.03	1.44	1.48	0.04	1.53	1.56	0.03	1.64	1.69	0.05
CFR03	0.62	0.64	0.02	1.15	1.16	0.02	1.32	1.36	0.05	1.41	1.46	0.05	1.57	1.62	0.05
NECF02	1.21	1.25	0.04	1.45	1.49	0.04	1.60	1.67	0.07	1.70	1.79	0.09	1.79	1.88	0.09
CFR02	1.22	1.26	0.03	2.49	2.58	0.09	2.92	3.02	0.09	3.09	3.17	0.08	3.33	3.46	0.13
CFR01	0.91	0.94	0.03	1.79	1.90	0.11	2.14	2.32	0.18	2.30	2.47	0.17	2.48	2.63	0.15
NECF01	1.63	1.72	0.08	2.22	2.32	0.10	2.67	2.86	0.20	2.83	2.99	0.16	2.98	3.13	0.15
Battleship	2.48	2.56	0.08	3.25	3.38	0.13	3.77	3.97	0.21	4.02	4.30	0.29	4.38	4.72	0.34
LowerAnchorageBasin	0.86	0.92	0.06	2.95	3.10	0.15	3.61	3.81	0.20	3.74	3.97	0.23	3.99	4.30	0.31
LowerBigIsland	2.70	2.49	-0.21	3.62	3.43	-0.19	4.20	3.99	-0.21	4.56	4.30	-0.26	5.17	5.03	-0.14
LowerLilliput	2.76	2.73	-0.03	4.15	4.00	-0.15	5.00	4.92	-0.08	5.42	5.34	-0.08	6.00	6.06	0.06
LowerMidnight	2.43	2.53	0.10	3.56	3.63	0.07	4.45	4.48	0.03	4.91	5.00	0.09	5.99	6.28	0.30
SnowMarsh	3.39	3.52	0.13	4.63	4.68	0.05	5.19	5.23	0.04	5.64	5.71	0.07	6.22	6.44	0.22
BatteryIsland	3.20	3.02	-0.18	4.77	4.48	-0.28	6.10	5.79	-0.30	6.53	6.65	0.11	7.08	7.52	0.43
BaldheadShoalR1	2.69	2.70	0.02	3.86	3.87	0.01	5.13	5.34	0.21	5.55	5.82	0.27	5.99	6.22	0.22
BaldheadShoalR3	0.77	0.76	0.00	1.01	1.02	0.02	1.32	1.37	0.05	1.64	1.65	0.01	2.55	2.70	0.15

Current speed (ft/s) percentile at surface layer for RSLR Low projection, Flow Medium condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.46	0.46	0.00	0.56	0.56	0.00	0.60	0.60	0.00	0.61	0.60	0.00	0.63	0.62	0.00
CFR04	1.12	1.14	0.02	1.44	1.45	0.01	1.56	1.57	0.01	1.59	1.60	0.01	1.63	1.64	0.01
CFR03	1.30	1.30	0.00	1.70	1.70	-0.01	1.93	1.93	0.00	1.99	1.99	0.00	2.04	2.04	0.00
CFR02	0.95	0.98	0.02	1.29	1.31	0.02	1.49	1.54	0.05	1.59	1.62	0.04	1.68	1.75	0.06
CFR01	0.65	0.65	0.00	1.21	1.22	0.01	1.41	1.43	0.02	1.47	1.49	0.02	1.53	1.54	0.01
NECF04	1.16	1.22	0.05	1.46	1.50	0.05	1.62	1.67	0.05	1.71	1.77	0.06	1.84	1.89	0.05
NECF03	1.30	1.28	-0.02	2.71	2.76	0.05	3.13	3.23	0.10	3.33	3.41	0.08	3.55	3.69	0.14
NECF02	0.80	0.85	0.05	1.74	1.96	0.22	2.07	2.29	0.22	2.20	2.45	0.25	2.43	2.58	0.15
NECF01	1.63	1.71	0.07	2.20	2.34	0.14	2.60	2.85	0.26	2.79	3.01	0.23	2.95	3.16	0.21
Battleship	2.47	2.58	0.11	3.29	3.47	0.19	3.89	4.10	0.21	4.05	4.36	0.30	4.47	4.85	0.38
LowerAnchorageBasin	0.82	0.90	0.08	3.05	3.25	0.20	3.78	4.04	0.26	3.89	4.16	0.27	4.00	4.40	0.40
LowerBigIsland	2.68	2.44	-0.24	3.71	3.52	-0.19	4.42	4.12	-0.30	4.75	4.51	-0.24	5.36	5.18	-0.18
LowerLilliput	2.75	2.71	-0.04	4.27	4.12	-0.15	5.26	5.11	-0.15	5.62	5.52	-0.10	6.26	6.19	-0.07
LowerMidnight	2.49	2.55	0.06	3.70	3.72	0.03	4.66	4.66	0.00	5.15	5.19	0.03	6.25	6.28	0.03
SnowMarsh	3.43	3.41	-0.02	4.71	4.75	0.04	5.38	5.41	0.03	5.76	5.84	0.08	6.44	6.49	0.05
BatteryIsland	3.25	2.98	-0.27	5.08	4.58	-0.49	6.27	5.93	-0.35	6.89	6.83	-0.06	7.70	8.03	0.33
BaldheadShoalR1	2.71	2.79	0.08	3.89	4.01	0.12	5.36	5.48	0.12	5.76	6.01	0.24	6.41	6.76	0.35
BaldheadShoalR3	0.83	0.82	-0.01	1.05	1.04	-0.01	1.38	1.38	0.00	1.62	1.65	0.03	2.66	2.87	0.21

Current speed (ft/s) percentile at surface layer for RSLR Low projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.55	0.54	-0.01	0.63	0.63	0.00	0.66	0.66	0.00	0.66	0.66	0.00	0.67	0.67	0.00
CFR04	1.11	1.12	0.01	1.49	1.50	0.01	1.59	1.61	0.02	1.62	1.63	0.01	1.65	1.66	0.02
CFR03	1.93	1.93	0.00	2.06	2.05	0.00	2.11	2.11	-0.01	2.13	2.12	-0.01	2.16	2.17	0.00
CFR02	0.93	0.94	0.01	1.38	1.39	0.01	1.57	1.61	0.04	1.66	1.71	0.05	1.77	1.82	0.05
CFR01	0.69	0.69	0.00	1.06	1.06	0.00	1.26	1.26	0.00	1.30	1.30	0.00	1.34	1.35	0.01
NECF04	1.15	1.18	0.02	1.53	1.54	0.02	1.69	1.73	0.05	1.77	1.83	0.06	1.89	1.95	0.06
NECF03	1.73	1.73	0.00	3.02	3.03	0.01	3.42	3.49	0.07	3.56	3.62	0.06	3.81	3.91	0.10
NECF02	0.72	0.75	0.03	1.53	1.80	0.27	1.96	2.23	0.26	2.11	2.41	0.30	2.51	2.79	0.28
NECF01	1.60	1.68	0.07	2.22	2.33	0.11	2.57	2.72	0.15	2.77	2.96	0.19	2.98	3.15	0.16
Battleship	2.46	2.55	0.09	3.42	3.62	0.20	3.96	4.29	0.32	4.27	4.64	0.37	4.77	4.93	0.16
LowerAnchorageBasin	0.90	0.80	-0.10	2.74	3.26	0.52	3.69	4.24	0.55	3.91	4.40	0.49	4.14	4.60	0.46
LowerBigIsland	2.60	2.35	-0.24	3.85	3.64	-0.22	4.79	4.42	-0.37	5.11	4.89	-0.22	5.71	5.52	-0.19
LowerLilliput	2.71	2.65	-0.06	4.51	4.41	-0.11	5.55	5.44	-0.12	5.94	5.91	-0.03	6.47	6.53	0.06
LowerMidnight	2.40	2.42	0.02	3.95	3.98	0.02	5.02	5.04	0.02	5.54	5.54	0.00	6.48	6.53	0.05
SnowMarsh	3.44	3.42	-0.02	4.74	4.83	0.08	5.47	5.53	0.06	5.97	6.05	0.08	6.55	6.81	0.27
BatteryIsland	3.36	2.94	-0.42	5.30	4.86	-0.44	6.57	6.15	-0.43	7.25	7.13	-0.12	8.58	8.57	-0.01
BaldheadShoalR1	2.82	2.86	0.04	4.19	4.28	0.09	5.67	5.78	0.11	6.12	6.26	0.14	6.80	7.16	0.36
BaldheadShoalR3	0.87	0.87	0.01	1.12	1.09	-0.03	1.39	1.43	0.04	1.63	1.69	0.06	3.13	3.02	-0.12

Current speed (ft/s) percentile at surface layer for RSLR Medium projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.39	0.39	0.01	0.50	0.50	0.00	0.54	0.54	0.00	0.54	0.54	0.00	0.55	0.55	0.00
NECF04	1.18	1.19	0.01	1.38	1.41	0.02	1.46	1.48	0.02	1.48	1.51	0.02	1.52	1.54	0.02
CFR04	0.98	0.99	0.01	1.36	1.35	-0.01	1.63	1.63	-0.01	1.69	1.69	0.00	1.73	1.74	0.00
NECF03	0.99	1.02	0.03	1.28	1.31	0.02	1.47	1.51	0.04	1.56	1.61	0.05	1.67	1.73	0.05
CFR03	0.68	0.70	0.02	1.12	1.13	0.01	1.39	1.41	0.01	1.45	1.46	0.01	1.51	1.52	0.01
NECF02	1.23	1.28	0.05	1.51	1.57	0.06	1.66	1.74	0.09	1.76	1.86	0.10	1.86	1.95	0.09
CFR02	1.26	1.28	0.02	2.47	2.49	0.02	2.93	3.02	0.09	3.13	3.21	0.08	3.36	3.49	0.13
CFR01	0.94	0.99	0.05	1.76	1.88	0.12	2.17	2.35	0.18	2.38	2.53	0.15	2.54	2.70	0.15
NECF01	1.74	1.78	0.05	2.32	2.39	0.07	2.72	2.89	0.17	2.87	3.03	0.16	3.02	3.20	0.19
Battleship	2.57	2.66	0.09	3.38	3.55	0.16	3.88	4.11	0.23	4.19	4.37	0.18	4.45	4.78	0.33
LowerAnchorageBasin	0.92	1.01	0.08	3.03	3.17	0.14	3.70	3.89	0.19	3.87	4.03	0.15	4.11	4.34	0.23
LowerBigIsland	2.82	2.57	-0.25	3.64	3.48	-0.15	4.23	4.06	-0.17	4.60	4.39	-0.21	5.29	5.10	-0.19
LowerLilliput	2.80	2.79	-0.01	4.10	3.98	-0.11	4.99	4.89	-0.10	5.45	5.33	-0.12	6.00	5.93	-0.07
LowerMidnight	2.50	2.58	0.08	3.56	3.57	0.01	4.33	4.48	0.15	4.77	4.95	0.19	6.02	6.21	0.19
SnowMarsh	3.31	3.40	0.09	4.57	4.63	0.05	5.11	5.21	0.10	5.46	5.62	0.16	6.02	6.48	0.46
BatteryIsland	3.17	3.02	-0.15	4.78	4.48	-0.30	6.09	5.88	-0.21	6.50	6.71	0.20	7.12	7.57	0.45
BaldheadShoalR1	2.75	2.75	0.01	3.83	3.92	0.09	5.08	5.25	0.16	5.52	5.76	0.23	5.97	6.18	0.21
BaldheadShoalR3	0.76	0.75	-0.01	1.01	1.04	0.03	1.38	1.40	0.02	1.68	1.73	0.05	2.35	2.56	0.20

Current speed (ft/s) percentile at surface layer for RSLR Medium projection, Flow Medium condition

Flow	**50%**			**75%**			**90%**			**95%**			**99%**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.44	0.44	0.00	0.54	0.54	0.00	0.57	0.57	0.00	0.58	0.58	0.00	0.60	0.61	0.01
CFR04	1.16	1.18	0.02	1.40	1.42	0.02	1.48	1.50	0.02	1.50	1.52	0.02	1.54	1.56	0.02
CFR03	1.32	1.31	0.00	1.49	1.49	0.00	1.64	1.63	-0.02	1.72	1.71	-0.01	1.81	1.81	0.00
CFR02	0.97	1.00	0.02	1.30	1.34	0.04	1.52	1.56	0.04	1.61	1.66	0.05	1.73	1.77	0.04
CFR01	0.65	0.65	0.00	1.03	1.05	0.02	1.28	1.28	0.01	1.32	1.33	0.00	1.38	1.38	0.01
NECF04	1.21	1.26	0.05	1.51	1.56	0.05	1.67	1.72	0.05	1.75	1.83	0.08	1.88	1.93	0.05
NECF03	1.31	1.32	0.01	2.66	2.68	0.02	3.12	3.21	0.09	3.26	3.36	0.09	3.54	3.63	0.09
NECF02	0.80	0.84	0.03	1.68	1.92	0.23	2.08	2.32	0.24	2.24	2.49	0.26	2.47	2.63	0.16
NECF01	1.71	1.76	0.06	2.29	2.41	0.12	2.69	2.90	0.22	2.86	3.06	0.20	2.99	3.22	0.23
Battleship	2.59	2.67	0.07	3.45	3.60	0.15	3.98	4.24	0.25	4.22	4.51	0.29	4.61	4.97	0.36
LowerAnchorageBasin	0.92	1.00	0.08	3.16	3.36	0.20	3.91	4.14	0.23	4.03	4.28	0.25	4.16	4.52	0.36
LowerBigIsland	2.75	2.49	-0.25	3.73	3.56	-0.17	4.48	4.23	-0.25	4.75	4.56	-0.19	5.49	5.28	-0.21
LowerLilliput	2.76	2.74	-0.02	4.23	4.14	-0.09	5.20	5.05	-0.16	5.59	5.42	-0.17	6.18	6.10	-0.08
LowerMidnight	2.49	2.55	0.06	3.70	3.74	0.05	4.49	4.58	0.09	4.95	5.06	0.11	6.15	6.31	0.15
SnowMarsh	3.40	3.39	-0.01	4.71	4.74	0.03	5.25	5.38	0.13	5.60	5.70	0.10	6.30	6.39	0.10
BatteryIsland	3.25	2.99	-0.26	5.08	4.67	-0.41	6.22	5.95	-0.27	6.86	7.02	0.16	7.68	8.04	0.36
BaldheadShoalR1	2.79	2.83	0.05	3.88	3.99	0.11	5.25	5.42	0.17	5.70	5.93	0.23	6.38	6.65	0.27
BaldheadShoalR3	0.82	0.81	-0.01	1.03	1.04	0.00	1.39	1.42	0.03	1.71	1.78	0.07	2.55	2.73	0.18

Current speed (ft/s) percentile at surface layer for RSLR Medium projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.50	0.50	0.00	0.59	0.59	0.00	0.62	0.62	0.00	0.63	0.63	0.00	0.64	0.64	0.00
CFR04	1.17	1.17	0.00	1.46	1.46	0.01	1.53	1.55	0.02	1.56	1.57	0.01	1.60	1.62	0.02
CFR03	1.91	1.90	-0.01	2.01	2.00	0.00	2.05	2.04	0.00	2.06	2.06	0.00	2.07	2.07	0.00
CFR02	0.94	0.96	0.02	1.38	1.38	0.00	1.60	1.62	0.02	1.65	1.71	0.05	1.79	1.84	0.05
CFR01	0.68	0.68	0.00	0.94	0.95	0.01	1.06	1.06	0.00	1.10	1.09	0.00	1.17	1.17	0.00
NECF04	1.19	1.23	0.04	1.55	1.59	0.05	1.73	1.78	0.05	1.81	1.87	0.06	1.94	2.00	0.06
NECF03	1.67	1.69	0.02	2.85	2.89	0.05	3.34	3.40	0.06	3.44	3.53	0.09	3.70	3.76	0.06
NECF02	0.68	0.72	0.04	1.52	1.80	0.28	1.85	2.16	0.32	2.06	2.38	0.32	2.28	2.65	0.37
NECF01	1.67	1.75	0.08	2.26	2.39	0.14	2.66	2.85	0.19	2.85	3.05	0.19	3.10	3.25	0.15
Battleship	2.66	2.75	0.09	3.59	3.73	0.14	4.09	4.43	0.34	4.47	4.73	0.26	4.90	5.05	0.15
LowerAnchorageBasin	0.95	0.91	-0.04	2.94	3.43	0.49	3.86	4.38	0.52	4.07	4.53	0.46	4.34	4.72	0.38
LowerBigIsland	2.69	2.41	-0.28	3.85	3.73	-0.12	4.84	4.48	-0.36	5.21	4.98	-0.23	5.76	5.59	-0.18
LowerLilliput	2.79	2.72	-0.06	4.42	4.31	-0.11	5.52	5.33	-0.19	5.86	5.72	-0.15	6.40	6.37	-0.03
LowerMidnight	2.40	2.41	0.01	3.88	3.95	0.08	4.86	4.84	-0.02	5.33	5.41	0.08	6.36	6.47	0.12
SnowMarsh	3.40	3.37	-0.03	4.75	4.85	0.10	5.48	5.48	0.00	5.92	5.95	0.03	6.40	6.67	0.27
BatteryIsland	3.30	3.01	-0.29	5.30	4.97	-0.34	6.56	6.25	-0.32	7.30	7.15	-0.15	8.49	8.74	0.24
BaldheadShoalR1	2.87	2.91	0.04	4.19	4.30	0.10	5.43	5.67	0.24	6.01	6.16	0.14	6.92	7.19	0.27
BaldheadShoalR3	0.86	0.86	0.00	1.09	1.08	-0.01	1.42	1.42	0.00	1.65	1.68	0.03	3.07	3.21	0.14

Current speed (ft/s) percentile at surface layer for RSLR High projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.42	0.43	0.01	0.49	0.49	0.01	0.51	0.52	0.00	0.52	0.53	0.01	0.54	0.55	0.01
NECF04	1.26	1.29	0.03	1.36	1.39	0.03	1.48	1.52	0.04	1.60	1.64	0.04	1.79	1.83	0.04
CFR04	0.95	0.95	0.00	0.99	0.99	0.00	1.01	1.02	0.01	1.02	1.03	0.00	1.04	1.05	0.01
NECF03	1.01	1.03	0.02	1.24	1.27	0.03	1.38	1.41	0.03	1.43	1.48	0.05	1.53	1.58	0.05
CFR03	0.70	0.71	0.02	0.82	0.83	0.02	0.86	0.88	0.02	0.89	0.91	0.02	0.98	1.02	0.04
NECF02	1.39	1.41	0.02	1.68	1.76	0.08	1.86	1.92	0.06	1.92	2.01	0.09	2.10	2.17	0.06
CFR02	1.43	1.47	0.04	2.03	2.07	0.04	2.42	2.50	0.08	2.56	2.63	0.06	2.75	2.84	0.09
CFR01	1.05	1.10	0.05	1.62	1.71	0.09	2.09	2.20	0.11	2.41	2.56	0.16	2.68	2.84	0.16
NECF01	1.94	2.00	0.06	2.47	2.57	0.10	2.85	2.98	0.14	3.01	3.15	0.14	3.22	3.40	0.18
Battleship	2.87	3.01	0.13	3.86	3.99	0.14	4.33	4.53	0.20	4.62	4.90	0.28	5.02	5.27	0.25
LowerAnchorageBasin	1.28	1.34	0.06	3.24	3.30	0.06	3.95	4.14	0.19	4.14	4.34	0.21	4.38	4.51	0.13
LowerBigIsland	3.04	2.87	-0.18	3.90	3.72	-0.17	4.47	4.29	-0.18	4.94	4.75	-0.19	5.40	5.26	-0.13
LowerLilliput	2.97	2.95	-0.02	3.93	3.85	-0.08	4.78	4.66	-0.12	5.16	5.08	-0.09	5.80	5.87	0.07
LowerMidnight	2.72	2.75	0.03	3.50	3.58	0.09	4.08	4.18	0.10	4.56	4.64	0.08	5.64	5.80	0.16
SnowMarsh	2.97	3.02	0.05	4.23	4.33	0.10	4.75	4.85	0.10	4.99	5.22	0.22	5.57	6.04	0.48
BatteryIsland	2.86	2.79	-0.06	4.43	4.40	-0.03	5.71	5.81	0.11	6.17	6.50	0.34	7.07	7.49	0.42
BaldheadShoalR1	2.81	2.84	0.03	3.85	3.94	0.09	4.96	5.07	0.10	5.34	5.47	0.13	5.96	6.22	0.26
BaldheadShoalR3	0.73	0.69	-0.04	0.99	1.01	0.02	1.36	1.47	0.11	1.73	1.97	0.24	2.40	2.67	0.27

Current speed (ft/s) percentile at surface layer for RSLR High projection, Flow Medium condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.42	0.43	0.01	0.49	0.49	0.00	0.52	0.52	0.01	0.52	0.53	0.01	0.54	0.54	0.00
CFR04	1.29	1.31	0.02	1.39	1.41	0.03	1.48	1.51	0.03	1.55	1.59	0.04	1.73	1.81	0.08
CFR03	1.20	1.19	-0.01	1.33	1.33	0.00	1.37	1.38	0.00	1.38	1.38	0.00	1.39	1.39	0.00
CFR02	1.00	1.02	0.02	1.22	1.25	0.04	1.36	1.40	0.04	1.42	1.46	0.04	1.50	1.54	0.05
CFR01	0.68	0.70	0.01	0.80	0.81	0.01	0.86	0.87	0.01	0.88	0.89	0.01	0.91	0.93	0.02
NECF04	1.38	1.42	0.05	1.65	1.71	0.07	1.82	1.90	0.07	1.93	1.98	0.05	2.13	2.21	0.07
NECF03	1.43	1.43	0.01	2.14	2.18	0.04	2.47	2.51	0.04	2.58	2.64	0.07	2.72	2.83	0.10
NECF02	0.87	0.90	0.03	1.51	1.64	0.13	1.95	2.14	0.19	2.15	2.39	0.24	2.48	2.68	0.20
NECF01	1.94	1.99	0.05	2.48	2.60	0.12	2.85	2.99	0.14	3.00	3.14	0.14	3.25	3.45	0.21
Battleship	2.87	3.00	0.13	3.85	4.00	0.15	4.39	4.61	0.22	4.71	4.99	0.28	5.09	5.37	0.27
LowerAnchorageBasin	1.27	1.30	0.03	3.39	3.39	0.00	4.21	4.44	0.24	4.36	4.61	0.25	4.47	4.74	0.27
LowerBigIsland	3.08	2.86	-0.22	3.96	3.77	-0.20	4.63	4.41	-0.22	5.07	4.83	-0.24	5.63	5.45	-0.18
LowerLilliput	2.99	2.99	0.00	3.92	3.82	-0.09	4.87	4.78	-0.09	5.33	5.26	-0.07	5.94	5.99	0.05
LowerMidnight	2.69	2.76	0.07	3.53	3.65	0.12	4.17	4.21	0.04	4.63	4.80	0.17	5.58	5.73	0.15
SnowMarsh	3.04	3.07	0.04	4.34	4.44	0.09	4.95	5.04	0.09	5.28	5.34	0.06	5.67	5.85	0.18
BatteryIsland	2.87	2.75	-0.12	4.62	4.47	-0.15	5.94	5.79	-0.15	6.51	6.74	0.23	7.50	7.89	0.39
BaldheadShoalR1	2.77	2.79	0.02	3.94	4.01	0.06	5.08	5.12	0.04	5.65	5.74	0.09	6.32	6.46	0.14
BaldheadShoalR3	0.78	0.77	-0.01	1.03	1.04	0.01	1.40	1.42	0.02	1.76	1.80	0.04	2.77	2.83	0.06

Current speed (ft/s) percentile at surface layer for RSLR High projection, Flow High condition

Flow	**50%**			**75%**			**90%**			**95%**			**99%**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.44	0.44	0.00	0.51	0.52	0.01	0.54	0.54	0.00	0.54	0.55	0.00	0.55	0.55	0.00
CFR04	1.33	1.36	0.03	1.45	1.48	0.03	1.52	1.55	0.03	1.56	1.59	0.03	1.67	1.72	0.05
CFR03	1.52	1.51	-0.01	1.69	1.68	-0.02	1.77	1.76	-0.01	1.80	1.79	-0.01	1.83	1.82	-0.01
CFR02	0.98	0.99	0.01	1.20	1.22	0.02	1.34	1.37	0.03	1.39	1.43	0.04	1.47	1.51	0.04
CFR01	0.65	0.66	0.01	0.80	0.82	0.02	0.86	0.88	0.01	0.88	0.90	0.01	0.91	0.93	0.02
NECF04	1.37	1.42	0.05	1.66	1.71	0.05	1.84	1.90	0.06	1.94	1.98	0.04	2.14	2.17	0.04
NECF03	1.51	1.55	0.04	2.26	2.29	0.03	2.51	2.56	0.05	2.59	2.64	0.05	2.72	2.79	0.08
NECF02	0.64	0.75	0.11	1.15	1.31	0.16	1.62	1.83	0.21	1.76	1.98	0.22	1.99	2.26	0.26
NECF01	1.94	2.01	0.07	2.45	2.60	0.16	2.87	3.02	0.16	3.02	3.20	0.18	3.33	3.48	0.15
Battleship	3.03	3.07	0.04	4.02	4.15	0.13	4.60	4.88	0.28	4.88	5.08	0.20	5.20	5.65	0.45
LowerAnchorageBasin	1.20	1.20	0.00	3.38	3.57	0.19	4.28	4.69	0.41	4.48	4.85	0.37	4.69	4.99	0.30
LowerBigIsland	3.11	2.91	-0.20	4.07	3.88	-0.19	4.90	4.68	-0.22	5.33	5.13	-0.20	5.85	5.81	-0.04
LowerLilliput	3.06	3.04	-0.01	4.04	3.92	-0.12	5.15	4.91	-0.24	5.59	5.39	-0.20	6.20	6.26	0.06
LowerMidnight	2.77	2.83	0.06	3.70	3.75	0.05	4.40	4.43	0.03	4.87	4.93	0.06	5.62	5.92	0.30
SnowMarsh	3.15	3.07	-0.08	4.39	4.53	0.14	5.19	5.30	0.11	5.50	5.59	0.10	5.92	6.03	0.11
BatteryIsland	2.97	2.76	-0.21	4.76	4.49	-0.27	6.14	5.87	-0.27	6.95	6.83	-0.11	8.04	8.63	0.60
BaldheadShoalR1	2.79	2.83	0.04	3.98	4.02	0.04	5.19	5.27	0.08	5.87	5.94	0.07	6.71	6.95	0.24
BaldheadShoalR3	0.83	0.82	-0.01	1.03	1.01	-0.02	1.36	1.38	0.02	1.69	1.76	0.07	2.90	3.13	0.23

Current speed (ft/s) percentile at middle layer for RSLR Low projection, Flow Low condition

Flow	**50%**			**75%**			**90%**			**95%**			**99%**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.38	0.38	0.00	0.54	0.53	-0.01	0.61	0.59	-0.01	0.64	0.63	-0.01	0.71	0.70	-0.02
NECF04	0.97	0.98	0.01	1.24	1.25	0.01	1.34	1.36	0.02	1.37	1.39	0.02	1.43	1.43	0.01
CFR04	0.97	0.94	-0.03	1.51	1.51	0.00	1.72	1.72	0.00	1.75	1.76	0.00	1.79	1.80	0.01
NECF03	0.85	0.87	0.02	1.15	1.20	0.04	1.34	1.38	0.04	1.42	1.45	0.03	1.52	1.57	0.05
CFR03	0.65	0.66	0.01	1.13	1.15	0.02	1.31	1.35	0.04	1.40	1.45	0.05	1.56	1.61	0.05
NECF02	1.04	1.07	0.03	1.29	1.32	0.04	1.45	1.49	0.04	1.51	1.58	0.07	1.63	1.69	0.05
CFR02	1.10	1.11	0.01	2.25	2.33	0.08	2.64	2.73	0.09	2.78	2.87	0.09	3.01	3.12	0.11
CFR01	0.82	0.84	0.02	1.69	1.76	0.07	1.93	2.04	0.10	2.06	2.18	0.12	2.30	2.43	0.13
NECF01	1.33	1.33	0.00	1.72	1.74	0.02	2.02	2.10	0.08	2.16	2.30	0.13	2.41	2.53	0.13
Battleship	2.48	2.56	0.08	3.07	3.18	0.10	3.44	3.62	0.18	3.74	3.93	0.19	4.03	4.30	0.27
LowerAnchorageBasin	0.92	0.99	0.07	1.34	1.45	0.11	1.86	1.74	-0.13	2.32	2.08	-0.23	2.78	2.74	-0.04
LowerBigIsland	2.77	2.69	-0.08	3.36	3.25	-0.11	3.75	3.73	-0.02	3.92	3.93	0.01	4.29	4.50	0.21
LowerLilliput	2.51	2.55	0.05	3.11	3.19	0.08	3.57	3.60	0.02	4.02	4.07	0.05	4.40	4.54	0.14
LowerMidnight	2.72	2.80	0.08	3.37	3.53	0.15	3.82	4.01	0.19	4.12	4.34	0.22	4.36	4.73	0.37
SnowMarsh	3.09	3.12	0.03	3.85	3.99	0.15	4.55	4.69	0.14	4.91	5.18	0.27	5.57	5.78	0.21
BatteryIsland	3.23	3.06	-0.16	4.15	4.08	-0.07	5.14	4.93	-0.21	5.63	5.65	0.02	6.34	6.80	0.47
BaldheadShoalR1	2.47	2.47	-0.01	3.24	3.36	0.12	3.98	4.18	0.20	4.30	4.48	0.18	5.02	5.19	0.16
BaldheadShoalR3	0.58	0.57	-0.01	0.76	0.77	0.01	0.92	0.95	0.03	1.04	1.07	0.03	1.25	1.42	0.17

Current speed (ft/s) percentile at middle layer for RSLR Low projection, Flow Medium condition

Flow	**50%**			**75%**			**90%**			**95%**			**99%**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.46	0.46	0.00	0.56	0.56	0.00	0.60	0.60	0.00	0.61	0.60	0.00	0.63	0.62	0.00
CFR04	0.93	0.96	0.03	1.27	1.28	0.01	1.37	1.38	0.01	1.40	1.41	0.01	1.44	1.45	0.01
CFR03	1.20	1.21	0.00	1.57	1.56	-0.01	1.78	1.78	0.00	1.84	1.84	0.00	1.88	1.88	0.00
CFR02	0.84	0.87	0.02	1.21	1.23	0.01	1.39	1.43	0.04	1.48	1.51	0.03	1.57	1.63	0.06
CFR01	0.66	0.66	0.00	1.16	1.18	0.01	1.38	1.39	0.01	1.42	1.44	0.02	1.48	1.50	0.01
NECF04	1.04	1.09	0.04	1.33	1.36	0.03	1.49	1.53	0.04	1.56	1.61	0.05	1.69	1.74	0.05
NECF03	1.17	1.15	-0.02	2.45	2.49	0.04	2.83	2.92	0.09	3.00	3.07	0.06	3.21	3.33	0.13
NECF02	0.81	0.81	0.00	1.72	1.91	0.18	2.01	2.19	0.18	2.21	2.39	0.18	2.45	2.64	0.19
NECF01	1.36	1.36	0.00	1.80	1.82	0.03	2.09	2.17	0.07	2.25	2.35	0.10	2.47	2.60	0.12
Battleship	2.45	2.47	0.01	3.10	3.19	0.09	3.50	3.69	0.19	3.85	4.03	0.18	4.16	4.41	0.25
LowerAnchorageBasin	1.00	1.10	0.10	1.42	1.50	0.08	1.77	1.72	-0.05	2.17	1.98	-0.18	2.72	2.68	-0.04
LowerBigIsland	2.85	2.61	-0.23	3.42	3.31	-0.11	3.81	3.86	0.05	4.07	4.15	0.08	4.39	4.63	0.24
LowerLilliput	2.49	2.63	0.15	3.17	3.24	0.07	3.60	3.71	0.11	4.01	4.04	0.04	4.39	4.44	0.05
LowerMidnight	2.80	2.85	0.05	3.49	3.63	0.14	3.93	4.19	0.26	4.22	4.48	0.25	4.60	4.86	0.27
SnowMarsh	3.09	3.18	0.08	3.88	3.97	0.09	4.47	4.66	0.20	4.88	5.00	0.12	5.61	5.80	0.18
BatteryIsland	3.27	3.15	-0.12	4.22	4.18	-0.04	5.00	5.02	0.02	5.70	5.71	0.01	6.62	7.04	0.42
BaldheadShoalR1	2.42	2.39	-0.03	3.32	3.42	0.10	3.96	4.19	0.23	4.49	4.69	0.19	4.97	5.11	0.14
BaldheadShoalR3	0.56	0.55	0.00	0.72	0.72	0.00	0.89	0.92	0.03	0.99	1.03	0.03	1.14	1.26	0.12

Current speed (ft/s) percentile at middle layer for RSLR Low projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.55	0.54	-0.01	0.63	0.63	0.00	0.66	0.66	0.00	0.66	0.66	0.00	0.67	0.67	0.00
CFR04	0.95	0.96	0.02	1.31	1.33	0.01	1.40	1.42	0.01	1.43	1.44	0.01	1.45	1.47	0.01
CFR03	1.78	1.78	0.00	1.90	1.89	0.00	1.95	1.94	0.00	1.97	1.96	-0.01	2.00	2.00	0.00
CFR02	0.81	0.83	0.02	1.29	1.30	0.01	1.47	1.51	0.04	1.55	1.60	0.04	1.65	1.70	0.05
CFR01	0.71	0.71	0.00	1.03	1.04	0.00	1.21	1.21	0.00	1.25	1.24	0.00	1.28	1.29	0.01
NECF04	1.04	1.06	0.02	1.39	1.42	0.03	1.55	1.60	0.04	1.63	1.68	0.05	1.74	1.80	0.06
NECF03	1.59	1.59	0.00	2.72	2.74	0.02	3.09	3.15	0.07	3.22	3.28	0.05	3.46	3.55	0.09
NECF02	0.79	0.79	0.00	1.74	1.93	0.19	2.16	2.37	0.21	2.34	2.55	0.21	2.61	2.90	0.29
NECF01	1.42	1.43	0.01	1.93	1.96	0.03	2.24	2.30	0.06	2.42	2.50	0.08	2.64	2.79	0.14
Battleship	2.39	2.47	0.09	3.20	3.35	0.15	3.73	3.95	0.21	3.98	4.27	0.29	4.38	4.71	0.34
LowerAnchorageBasin	1.06	1.07	0.01	1.52	1.60	0.08	1.75	1.92	0.17	1.91	2.06	0.15	2.26	2.37	0.11
LowerBigIsland	2.82	2.53	-0.29	3.55	3.54	-0.02	3.92	4.00	0.08	4.15	4.35	0.20	4.70	4.94	0.24
LowerLilliput	2.68	2.83	0.14	3.34	3.44	0.11	3.83	4.01	0.17	4.12	4.29	0.17	4.58	4.69	0.10
LowerMidnight	2.81	2.86	0.04	3.62	3.74	0.12	4.10	4.31	0.21	4.36	4.71	0.36	4.75	5.10	0.35
SnowMarsh	3.21	3.20	-0.01	3.96	3.98	0.02	4.47	4.73	0.26	4.76	5.10	0.33	5.25	5.65	0.41
BatteryIsland	3.39	3.12	-0.27	4.36	4.29	-0.07	5.11	5.29	0.19	5.77	5.89	0.11	7.23	7.45	0.22
BaldheadShoalR1	2.35	2.30	-0.05	3.22	3.33	0.11	4.20	4.37	0.17	4.56	4.73	0.18	5.22	5.43	0.20
BaldheadShoalR3	0.53	0.53	0.00	0.68	0.69	0.01	0.84	0.87	0.02	0.99	0.98	-0.01	1.12	1.12	0.00

Current speed (ft/s) percentile at middle layer for RSLR Medium projection, Flow Low condition

Flow	**50%**			**75%**			**90%**			**95%**			**99%**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.39	0.39	0.01	0.50	0.50	0.00	0.54	0.54	0.00	0.54	0.54	0.00	0.55	0.55	0.00
NECF04	0.99	1.00	0.00	1.21	1.23	0.02	1.28	1.30	0.02	1.31	1.32	0.01	1.34	1.35	0.01
CFR04	0.90	0.91	0.01	1.26	1.24	-0.01	1.51	1.50	-0.01	1.56	1.56	0.00	1.60	1.60	0.00
NECF03	0.88	0.90	0.02	1.17	1.19	0.02	1.37	1.42	0.05	1.46	1.50	0.04	1.56	1.61	0.05
CFR03	0.69	0.71	0.02	1.09	1.09	0.00	1.36	1.36	0.01	1.41	1.42	0.02	1.47	1.49	0.02
NECF02	1.08	1.11	0.03	1.33	1.37	0.04	1.48	1.53	0.05	1.56	1.63	0.06	1.67	1.72	0.05
CFR02	1.12	1.15	0.02	2.23	2.26	0.04	2.65	2.74	0.09	2.82	2.90	0.08	3.04	3.16	0.12
CFR01	0.82	0.83	0.01	1.68	1.75	0.07	1.96	2.08	0.13	2.09	2.22	0.13	2.30	2.47	0.17
NECF01	1.37	1.37	0.01	1.79	1.82	0.03	2.07	2.16	0.09	2.22	2.32	0.10	2.44	2.58	0.14
Battleship	2.55	2.63	0.08	3.21	3.35	0.15	3.60	3.79	0.19	3.90	4.12	0.21	4.27	4.45	0.18
LowerAnchorageBasin	0.93	1.01	0.09	1.37	1.47	0.10	2.00	1.88	-0.12	2.42	2.27	-0.14	2.94	2.87	-0.07
LowerBigIsland	2.76	2.71	-0.05	3.35	3.30	-0.05	3.74	3.77	0.02	3.96	4.03	0.07	4.28	4.45	0.17
LowerLilliput	2.48	2.58	0.10	3.08	3.15	0.07	3.61	3.62	0.00	4.05	4.16	0.12	4.41	4.56	0.15
LowerMidnight	2.68	2.77	0.09	3.31	3.46	0.15	3.78	3.97	0.19	4.05	4.21	0.17	4.27	4.60	0.32
SnowMarsh	3.01	3.05	0.04	3.81	3.91	0.10	4.53	4.69	0.16	4.80	5.10	0.30	5.43	5.80	0.37
BatteryIsland	3.22	3.09	-0.13	4.18	4.08	-0.10	5.12	4.96	-0.16	5.59	5.72	0.13	6.34	6.76	0.42
BaldheadShoalR1	2.50	2.53	0.03	3.28	3.40	0.12	3.92	4.14	0.23	4.30	4.47	0.17	5.09	5.34	0.25
BaldheadShoalR3	0.60	0.60	0.00	0.77	0.78	0.01	0.93	0.96	0.04	1.05	1.08	0.03	1.38	1.56	0.18

Current speed (ft/s) percentile at middle layer for RSLR Medium projection, Flow Medium condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.44	0.44	0.00	0.54	0.54	0.00	0.57	0.57	0.00	0.58	0.58	0.00	0.60	0.61	0.01
CFR04	0.97	0.99	0.02	1.23	1.25	0.02	1.31	1.32	0.02	1.32	1.34	0.01	1.36	1.37	0.02
CFR03	1.21	1.21	0.00	1.37	1.38	0.00	1.52	1.50	-0.02	1.59	1.58	-0.01	1.67	1.67	0.00
CFR02	0.85	0.87	0.02	1.21	1.23	0.03	1.43	1.46	0.04	1.51	1.55	0.05	1.62	1.65	0.04
CFR01	0.65	0.65	0.00	0.99	1.00	0.01	1.21	1.21	0.00	1.25	1.25	0.00	1.30	1.31	0.01
NECF04	1.07	1.09	0.02	1.37	1.40	0.02	1.53	1.58	0.05	1.60	1.66	0.06	1.72	1.77	0.05
NECF03	1.18	1.18	0.00	2.41	2.44	0.03	2.82	2.91	0.08	2.95	3.05	0.09	3.20	3.30	0.09
NECF02	0.77	0.80	0.02	1.74	1.90	0.16	2.03	2.21	0.18	2.22	2.40	0.19	2.40	2.65	0.25
NECF01	1.38	1.38	0.00	1.84	1.85	0.02	2.15	2.23	0.08	2.30	2.40	0.10	2.51	2.65	0.14
Battleship	2.54	2.59	0.05	3.27	3.40	0.12	3.65	3.88	0.23	4.02	4.19	0.18	4.32	4.57	0.25
LowerAnchorageBasin	1.02	1.12	0.10	1.43	1.53	0.10	1.94	1.83	-0.11	2.37	2.15	-0.22	2.87	2.86	-0.01
LowerBigIsland	2.83	2.64	-0.19	3.44	3.36	-0.08	3.85	3.90	0.04	4.10	4.22	0.12	4.42	4.67	0.25
LowerLilliput	2.50	2.65	0.15	3.15	3.23	0.08	3.58	3.69	0.11	4.01	4.04	0.03	4.42	4.43	0.01
LowerMidnight	2.75	2.81	0.07	3.44	3.55	0.11	3.90	4.09	0.20	4.15	4.40	0.25	4.49	4.69	0.20
SnowMarsh	3.05	3.13	0.08	3.85	3.95	0.10	4.44	4.62	0.17	4.82	5.02	0.20	5.64	5.73	0.09
BatteryIsland	3.24	3.12	-0.12	4.21	4.20	0.00	5.08	5.04	-0.04	5.80	5.75	-0.05	6.57	7.17	0.60
BaldheadShoalR1	2.47	2.46	-0.01	3.31	3.43	0.11	3.97	4.10	0.13	4.42	4.63	0.21	5.00	5.24	0.23
BaldheadShoalR3	0.57	0.56	-0.02	0.73	0.74	0.01	0.91	0.94	0.03	1.00	1.03	0.03	1.22	1.32	0.10

Current speed (ft/s) percentile at middle layer for RSLR Medium projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.50	0.50	0.00	0.59	0.59	0.00	0.62	0.62	0.00	0.63	0.63	0.00	0.64	0.64	0.00
CFR04	0.99	1.00	0.01	1.29	1.30	0.00	1.36	1.37	0.01	1.38	1.39	0.01	1.41	1.43	0.02
CFR03	1.76	1.75	-0.01	1.85	1.85	0.00	1.89	1.88	0.00	1.90	1.90	0.00	1.91	1.91	0.00
CFR02	0.83	0.83	0.01	1.29	1.29	0.00	1.50	1.52	0.03	1.55	1.60	0.05	1.67	1.72	0.04
CFR01	0.69	0.69	0.00	0.94	0.94	0.00	1.04	1.05	0.00	1.08	1.08	0.00	1.13	1.13	0.00
NECF04	1.07	1.11	0.04	1.42	1.46	0.04	1.59	1.63	0.04	1.66	1.72	0.06	1.79	1.84	0.05
NECF03	1.52	1.55	0.03	2.60	2.63	0.03	3.04	3.08	0.04	3.12	3.20	0.08	3.36	3.42	0.05
NECF02	0.73	0.77	0.03	1.70	1.92	0.22	2.09	2.31	0.22	2.28	2.54	0.26	2.52	2.82	0.30
NECF01	1.47	1.46	-0.01	1.95	2.00	0.05	2.29	2.36	0.07	2.46	2.54	0.08	2.70	2.83	0.13
Battleship	2.56	2.60	0.04	3.41	3.48	0.07	3.89	4.10	0.22	4.12	4.39	0.27	4.56	4.80	0.25
LowerAnchorageBasin	1.08	1.14	0.06	1.55	1.73	0.18	1.84	1.99	0.14	2.02	2.15	0.13	2.48	2.54	0.07
LowerBigIsland	2.90	2.61	-0.29	3.61	3.56	-0.05	3.98	4.09	0.11	4.25	4.41	0.16	4.76	5.01	0.25
LowerLilliput	2.68	2.83	0.15	3.31	3.42	0.10	3.82	4.00	0.17	4.10	4.32	0.22	4.66	4.74	0.08
LowerMidnight	2.82	2.83	0.01	3.60	3.69	0.08	4.08	4.27	0.19	4.31	4.62	0.30	4.61	4.97	0.36
SnowMarsh	3.11	3.18	0.07	3.91	3.97	0.06	4.40	4.60	0.20	4.78	5.03	0.25	5.22	5.53	0.30
BatteryIsland	3.27	3.14	-0.12	4.36	4.28	-0.08	5.10	5.31	0.21	5.82	5.96	0.14	7.17	7.49	0.32
BaldheadShoalR1	2.39	2.37	-0.01	3.31	3.37	0.06	4.17	4.29	0.12	4.48	4.63	0.14	5.22	5.49	0.27
BaldheadShoalR3	0.53	0.53	0.00	0.70	0.70	0.00	0.86	0.89	0.03	1.00	1.00	0.01	1.15	1.14	-0.01

Current speed (ft/s) percentile at middle layer for RSLR High projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.42	0.43	0.01	0.49	0.49	0.01	0.51	0.52	0.00	0.52	0.53	0.01	0.54	0.55	0.01
NECF04	1.10	1.12	0.02	1.19	1.22	0.03	1.27	1.29	0.03	1.32	1.35	0.03	1.48	1.51	0.03
CFR04	0.88	0.88	0.00	0.91	0.92	0.00	0.94	0.94	0.01	0.95	0.95	0.00	0.96	0.97	0.01
NECF03	0.90	0.92	0.02	1.11	1.15	0.04	1.27	1.30	0.03	1.35	1.39	0.04	1.44	1.49	0.04
CFR03	0.70	0.72	0.02	0.82	0.83	0.01	0.89	0.90	0.01	0.93	0.96	0.03	1.08	1.12	0.04
NECF02	1.17	1.19	0.02	1.49	1.53	0.04	1.67	1.72	0.06	1.76	1.82	0.05	1.99	2.07	0.08
CFR02	1.28	1.33	0.04	1.86	1.92	0.06	2.23	2.30	0.07	2.36	2.42	0.06	2.54	2.62	0.09
CFR01	0.83	0.86	0.03	1.49	1.62	0.14	2.01	2.19	0.18	2.14	2.30	0.16	2.26	2.44	0.19
NECF01	1.51	1.54	0.03	2.00	2.07	0.07	2.22	2.31	0.10	2.39	2.49	0.10	2.64	2.72	0.08
Battleship	3.03	3.15	0.12	3.78	3.94	0.16	4.26	4.47	0.20	4.49	4.70	0.20	4.90	5.14	0.24
LowerAnchorageBasin	1.02	1.13	0.10	1.61	1.73	0.12	2.57	2.40	-0.17	2.94	2.69	-0.26	3.30	3.20	-0.10
LowerBigIsland	2.77	2.90	0.13	3.64	3.68	0.04	4.16	4.16	0.00	4.40	4.37	-0.03	4.71	4.79	0.09
LowerLilliput	2.70	2.78	0.08	3.28	3.37	0.09	3.92	3.91	-0.01	4.25	4.41	0.15	4.66	4.77	0.11
LowerMidnight	2.55	2.63	0.08	3.23	3.36	0.13	3.64	3.88	0.24	3.89	4.16	0.26	4.23	4.42	0.19
SnowMarsh	2.74	2.84	0.09	3.55	3.68	0.13	4.20	4.46	0.26	4.56	4.84	0.28	5.27	5.53	0.26
BatteryIsland	2.96	2.94	-0.02	3.95	3.97	0.02	4.89	4.96	0.07	5.36	5.57	0.21	6.04	6.85	0.80
BaldheadShoalR1	2.45	2.55	0.09	3.31	3.44	0.12	3.91	4.04	0.13	4.48	4.60	0.12	5.22	5.51	0.29
BaldheadShoalR3	0.63	0.64	0.01	0.81	0.82	0.02	0.97	0.97	0.00	1.10	1.13	0.03	1.38	1.61	0.23

Current speed (ft/s) percentile at middle layer for RSLR High projection, Flow Medium condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.42	0.43	0.01	0.49	0.49	0.00	0.52	0.52	0.01	0.52	0.53	0.01	0.54	0.54	0.00
CFR04	1.13	1.15	0.02	1.22	1.25	0.03	1.29	1.32	0.03	1.32	1.35	0.03	1.43	1.50	0.07
CFR03	1.11	1.10	-0.01	1.23	1.23	0.00	1.27	1.27	0.00	1.28	1.28	0.00	1.29	1.29	0.00
CFR02	0.89	0.92	0.03	1.10	1.13	0.03	1.28	1.31	0.03	1.34	1.38	0.04	1.41	1.46	0.04
CFR01	0.68	0.69	0.02	0.81	0.82	0.02	0.85	0.86	0.01	0.87	0.89	0.02	0.97	1.00	0.03
NECF04	1.20	1.22	0.02	1.51	1.55	0.04	1.68	1.74	0.06	1.77	1.83	0.06	1.97	2.05	0.08
NECF03	1.31	1.31	0.00	1.97	2.01	0.04	2.28	2.34	0.06	2.39	2.45	0.06	2.53	2.62	0.09
NECF02	0.76	0.79	0.03	1.59	1.72	0.13	1.94	2.19	0.25	2.10	2.30	0.20	2.30	2.53	0.23
NECF01	1.53	1.55	0.02	2.02	2.09	0.07	2.28	2.34	0.06	2.42	2.53	0.11	2.68	2.79	0.11
Battleship	2.96	3.15	0.18	3.80	3.94	0.14	4.29	4.48	0.19	4.56	4.79	0.23	4.86	5.12	0.26
LowerAnchorageBasin	1.11	1.19	0.08	1.62	1.73	0.11	2.45	2.34	-0.11	2.92	2.64	-0.28	3.33	3.20	-0.14
LowerBigIsland	2.87	2.94	0.08	3.74	3.78	0.04	4.23	4.26	0.03	4.45	4.61	0.15	4.85	4.98	0.13
LowerLilliput	2.74	2.85	0.11	3.29	3.41	0.13	3.90	4.00	0.10	4.35	4.27	-0.08	4.76	4.86	0.10
LowerMidnight	2.64	2.73	0.08	3.35	3.45	0.10	3.76	3.94	0.19	3.94	4.23	0.29	4.46	4.60	0.14
SnowMarsh	2.76	2.92	0.16	3.53	3.67	0.14	4.15	4.33	0.18	4.48	4.80	0.32	5.35	5.60	0.25
BatteryIsland	3.02	3.01	0.00	3.99	4.02	0.03	4.88	5.01	0.14	5.56	5.56	0.00	6.25	7.16	0.91
BaldheadShoalR1	2.39	2.44	0.05	3.31	3.39	0.09	3.94	4.11	0.16	4.32	4.65	0.33	5.04	5.22	0.19
BaldheadShoalR3	0.61	0.61	-0.01	0.78	0.79	0.01	0.95	0.95	0.00	1.03	1.04	0.01	1.24	1.37	0.13

Current speed (ft/s) percentile at middle layer for RSLR High projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.44	0.44	0.00	0.51	0.52	0.01	0.54	0.54	0.00	0.54	0.55	0.00	0.55	0.55	0.00
CFR04	1.15	1.17	0.02	1.29	1.31	0.02	1.35	1.37	0.02	1.38	1.41	0.03	1.41	1.45	0.04
CFR03	1.41	1.39	-0.01	1.56	1.55	-0.01	1.63	1.63	-0.01	1.66	1.65	-0.01	1.69	1.69	0.00
CFR02	0.88	0.89	0.01	1.10	1.12	0.02	1.26	1.30	0.03	1.32	1.36	0.03	1.39	1.43	0.04
CFR01	0.64	0.65	0.01	0.81	0.82	0.01	0.86	0.87	0.01	0.88	0.89	0.01	0.90	0.91	0.02
NECF04	1.25	1.29	0.04	1.52	1.57	0.05	1.69	1.74	0.05	1.78	1.83	0.05	1.96	2.00	0.05
NECF03	1.41	1.44	0.03	2.11	2.13	0.02	2.35	2.39	0.04	2.43	2.48	0.05	2.55	2.62	0.07
NECF02	0.67	0.75	0.08	1.30	1.51	0.21	1.86	2.05	0.18	2.01	2.21	0.20	2.28	2.55	0.27
NECF01	1.59	1.64	0.05	2.09	2.14	0.05	2.40	2.46	0.06	2.55	2.64	0.08	2.87	2.98	0.11
Battleship	2.98	3.12	0.14	3.87	4.02	0.15	4.34	4.50	0.16	4.68	4.92	0.24	5.00	5.25	0.24
LowerAnchorageBasin	1.23	1.31	0.09	1.75	1.91	0.16	2.23	2.26	0.02	2.62	2.47	-0.15	3.12	3.03	-0.10
LowerBigIsland	3.06	3.03	-0.04	3.81	3.90	0.09	4.34	4.45	0.12	4.58	4.75	0.17	4.96	5.18	0.22
LowerLilliput	2.79	2.91	0.12	3.39	3.56	0.17	4.02	4.15	0.13	4.31	4.50	0.19	4.84	5.00	0.16
LowerMidnight	2.68	2.77	0.09	3.53	3.60	0.07	3.94	4.08	0.14	4.15	4.40	0.25	4.61	4.82	0.22
SnowMarsh	2.82	2.98	0.15	3.56	3.64	0.08	4.08	4.21	0.13	4.43	4.62	0.19	5.23	5.30	0.07
BatteryIsland	3.04	2.99	-0.05	4.14	4.12	-0.02	5.01	4.97	-0.04	5.70	5.97	0.28	6.81	6.98	0.18
BaldheadShoalR1	2.37	2.42	0.05	3.22	3.33	0.10	4.02	4.19	0.17	4.47	4.64	0.17	5.20	5.54	0.34
BaldheadShoalR3	0.56	0.55	-0.01	0.74	0.75	0.00	0.89	0.92	0.03	1.00	1.05	0.05	1.17	1.19	0.03

Current speed (ft/s) percentile at bottom layer for RSLR Low projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.38	0.38	0.00	0.54	0.53	-0.01	0.61	0.59	-0.01	0.64	0.63	-0.01	0.71	0.70	-0.02
NECF04	0.97	0.98	0.01	1.24	1.25	0.01	1.34	1.36	0.02	1.37	1.39	0.02	1.43	1.43	0.01
CFR04	0.82	0.80	-0.03	1.27	1.28	0.00	1.44	1.45	0.00	1.47	1.48	0.00	1.51	1.52	0.01
NECF03	0.65	0.67	0.02	0.97	1.01	0.03	1.12	1.16	0.04	1.19	1.22	0.02	1.28	1.32	0.04
CFR03	0.65	0.66	0.01	1.13	1.15	0.02	1.31	1.35	0.04	1.40	1.45	0.05	1.56	1.61	0.05
NECF02	0.78	0.80	0.02	0.98	1.00	0.02	1.11	1.14	0.03	1.17	1.21	0.04	1.25	1.29	0.04
CFR02	0.75	0.76	0.01	1.58	1.62	0.05	1.84	1.90	0.06	1.93	1.99	0.06	2.10	2.18	0.09
CFR01	0.77	0.77	0.00	1.29	1.30	0.01	1.53	1.57	0.04	1.62	1.70	0.08	1.74	1.84	0.10
NECF01	0.79	0.78	-0.01	1.10	1.07	-0.03	1.31	1.36	0.04	1.45	1.49	0.05	1.67	1.76	0.09
Battleship	1.62	1.70	0.08	2.23	2.33	0.10	2.57	2.72	0.15	2.71	2.89	0.18	2.88	3.13	0.24
LowerAnchorageBasin	0.28	0.18	-0.10	0.94	0.77	-0.17	1.31	1.22	-0.09	1.52	1.42	-0.10	1.90	2.01	0.10
LowerBigIsland	1.67	1.83	0.15	2.26	2.33	0.07	2.53	2.64	0.12	2.65	2.76	0.10	3.03	3.11	0.08
LowerLilliput	1.62	1.81	0.19	1.99	2.27	0.29	2.34	2.66	0.32	2.54	2.83	0.29	3.07	3.41	0.34
LowerMidnight	1.82	2.02	0.19	2.26	2.48	0.21	2.61	2.89	0.29	2.82	3.14	0.32	3.24	3.54	0.30
SnowMarsh	2.16	2.56	0.40	2.73	3.20	0.48	3.35	3.87	0.52	3.64	4.32	0.68	4.28	4.79	0.51
BatteryIsland	2.57	2.57	0.00	3.29	3.26	-0.03	3.85	3.73	-0.12	4.43	4.37	-0.06	5.20	5.35	0.15
BaldheadShoalR1	2.02	2.30	0.28	2.52	2.87	0.35	2.93	3.43	0.51	3.21	3.80	0.59	3.85	4.37	0.53
BaldheadShoalR3	0.43	0.45	0.02	0.54	0.56	0.02	0.64	0.69	0.06	0.71	0.75	0.04	0.84	0.91	0.07

Current speed (ft/s) percentile at bottom layer for RSLR Low projection, Flow Medium condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.46	0.46	0.00	0.56	0.56	0.00	0.60	0.60	0.00	0.61	0.60	0.00	0.63	0.62	0.00
CFR04	0.93	0.96	0.03	1.27	1.28	0.01	1.37	1.38	0.01	1.40	1.41	0.01	1.44	1.45	0.01
CFR03	1.02	1.02	0.00	1.32	1.32	-0.01	1.50	1.50	0.00	1.55	1.55	-0.01	1.58	1.59	0.00
CFR02	0.64	0.65	0.01	1.01	1.04	0.03	1.17	1.20	0.03	1.24	1.26	0.02	1.32	1.37	0.05
CFR01	0.66	0.66	0.00	1.16	1.18	0.01	1.38	1.39	0.01	1.42	1.44	0.02	1.48	1.50	0.01
NECF04	0.79	0.82	0.02	1.03	1.05	0.02	1.15	1.18	0.03	1.21	1.25	0.04	1.31	1.34	0.04
NECF03	0.80	0.80	-0.01	1.71	1.76	0.04	1.98	2.03	0.05	2.10	2.13	0.03	2.24	2.32	0.08
NECF02	0.71	0.72	0.01	1.43	1.45	0.02	1.66	1.72	0.06	1.77	1.85	0.07	1.91	2.01	0.10
NECF01	0.87	0.81	-0.05	1.17	1.14	-0.03	1.47	1.48	0.01	1.59	1.61	0.02	1.79	1.88	0.09
Battleship	1.53	1.65	0.12	2.24	2.38	0.14	2.63	2.79	0.17	2.74	2.95	0.21	2.92	3.15	0.24
LowerAnchorageBasin	0.24	0.15	-0.10	0.88	0.69	-0.18	1.28	1.15	-0.13	1.49	1.38	-0.11	1.96	1.98	0.02
LowerBigIsland	1.60	1.83	0.23	2.26	2.33	0.07	2.53	2.65	0.12	2.65	2.80	0.14	3.04	3.02	-0.02
LowerLilliput	1.55	1.79	0.24	1.96	2.25	0.29	2.28	2.61	0.32	2.47	2.80	0.34	2.88	3.18	0.30
LowerMidnight	1.79	2.01	0.23	2.31	2.51	0.20	2.59	2.82	0.23	2.76	3.13	0.37	3.20	3.51	0.31
SnowMarsh	2.20	2.63	0.43	2.68	3.23	0.55	3.25	3.85	0.59	3.52	4.19	0.68	4.21	4.85	0.63
BatteryIsland	2.54	2.59	0.05	3.32	3.40	0.08	3.82	3.85	0.03	4.37	4.10	-0.26	5.16	4.78	-0.38
BaldheadShoalR1	2.09	2.35	0.26	2.57	2.88	0.30	3.04	3.39	0.35	3.25	3.80	0.56	3.77	4.34	0.57
BaldheadShoalR3	0.42	0.44	0.01	0.52	0.54	0.02	0.63	0.66	0.03	0.71	0.75	0.04	0.84	0.83	0.00

Current speed (ft/s) percentile at bottom layer for RSLR Low projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.55	0.54	-0.01	0.63	0.63	0.00	0.66	0.66	0.00	0.66	0.66	0.00	0.67	0.67	0.00
CFR04	0.95	0.96	0.02	1.31	1.33	0.01	1.40	1.42	0.01	1.43	1.44	0.01	1.45	1.47	0.01
CFR03	1.50	1.50	0.00	1.60	1.60	0.00	1.64	1.64	0.00	1.66	1.65	-0.01	1.69	1.69	0.00
CFR02	0.63	0.63	0.01	1.08	1.09	0.01	1.24	1.27	0.04	1.31	1.34	0.03	1.39	1.43	0.04
CFR01	0.71	0.71	0.00	1.03	1.04	0.00	1.21	1.21	0.00	1.25	1.24	0.00	1.28	1.29	0.01
NECF04	0.79	0.80	0.02	1.07	1.10	0.03	1.20	1.24	0.03	1.26	1.31	0.04	1.35	1.40	0.04
NECF03	1.13	1.11	-0.02	1.91	1.92	0.02	2.16	2.21	0.05	2.25	2.32	0.07	2.42	2.49	0.07
NECF02	0.75	0.74	-0.01	1.67	1.71	0.04	1.91	1.97	0.06	2.04	2.10	0.06	2.23	2.27	0.04
NECF01	0.99	0.93	-0.05	1.40	1.35	-0.05	1.67	1.69	0.02	1.80	1.84	0.04	1.99	2.06	0.08
Battleship	1.47	1.51	0.04	2.35	2.45	0.11	2.68	2.87	0.19	2.95	3.09	0.15	3.32	3.37	0.05
LowerAnchorageBasin	0.23	0.15	-0.08	0.81	0.48	-0.33	1.19	1.04	-0.14	1.39	1.30	-0.09	1.77	1.79	0.02
LowerBigIsland	1.54	1.82	0.27	2.23	2.31	0.07	2.46	2.63	0.17	2.57	2.79	0.22	3.00	3.01	0.01
LowerLilliput	1.53	1.81	0.28	1.93	2.21	0.27	2.23	2.54	0.31	2.40	2.78	0.38	2.78	3.07	0.29
LowerMidnight	1.75	1.95	0.20	2.32	2.51	0.19	2.61	2.85	0.25	2.79	3.12	0.33	3.07	3.41	0.34
SnowMarsh	2.28	2.64	0.37	2.73	3.22	0.48	3.17	3.77	0.60	3.38	4.05	0.67	3.95	4.75	0.80
BatteryIsland	2.57	2.58	0.01	3.30	3.39	0.09	3.96	4.07	0.11	4.39	4.29	-0.10	5.14	4.73	-0.41
BaldheadShoalR1	2.12	2.40	0.28	2.64	2.95	0.31	2.96	3.38	0.42	3.31	3.86	0.55	3.73	4.34	0.61
BaldheadShoalR3	0.40	0.41	0.01	0.50	0.52	0.02	0.61	0.63	0.01	0.71	0.71	0.01	0.81	0.83	0.02

Current speed (ft/s) percentile at bottom layer for RSLR Medium projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.39	0.39	0.01	0.50	0.50	0.00	0.54	0.54	0.00	0.54	0.54	0.00	0.55	0.55	0.00
NECF04	0.99	1.00	0.00	1.21	1.23	0.02	1.28	1.30	0.02	1.31	1.32	0.01	1.34	1.35	0.01
CFR04	0.76	0.77	0.01	1.06	1.05	-0.01	1.27	1.27	0.00	1.31	1.31	0.00	1.35	1.35	0.00
NECF03	0.66	0.68	0.01	0.98	1.00	0.02	1.16	1.19	0.03	1.23	1.26	0.03	1.32	1.36	0.04
CFR03	0.69	0.71	0.02	1.09	1.09	0.00	1.36	1.36	0.01	1.41	1.42	0.02	1.47	1.49	0.02
NECF02	0.80	0.81	0.01	1.02	1.03	0.02	1.14	1.17	0.03	1.19	1.23	0.04	1.27	1.31	0.04
CFR02	0.77	0.78	0.01	1.56	1.58	0.02	1.85	1.92	0.07	1.98	2.02	0.05	2.13	2.21	0.08
CFR01	0.77	0.77	-0.01	1.34	1.36	0.02	1.57	1.62	0.05	1.67	1.74	0.07	1.78	1.88	0.10
NECF01	0.83	0.83	0.00	1.12	1.11	-0.01	1.33	1.39	0.06	1.49	1.53	0.04	1.69	1.78	0.09
Battleship	1.73	1.77	0.04	2.34	2.43	0.10	2.67	2.82	0.15	2.79	2.98	0.19	2.99	3.20	0.21
LowerAnchorageBasin	0.27	0.20	-0.07	0.96	0.84	-0.12	1.40	1.30	-0.10	1.61	1.57	-0.04	2.02	2.12	0.10
LowerBigIsland	1.73	1.87	0.14	2.30	2.39	0.09	2.54	2.68	0.13	2.74	2.83	0.09	3.10	3.24	0.14
LowerLilliput	1.65	1.85	0.20	2.01	2.30	0.29	2.34	2.66	0.32	2.57	2.87	0.30	3.03	3.41	0.38
LowerMidnight	1.82	2.03	0.21	2.27	2.47	0.19	2.58	2.88	0.30	2.77	3.08	0.30	3.15	3.49	0.34
SnowMarsh	2.15	2.54	0.39	2.69	3.20	0.52	3.32	3.90	0.58	3.61	4.23	0.62	4.19	4.84	0.65
BatteryIsland	2.52	2.55	0.03	3.29	3.25	-0.05	3.87	3.80	-0.07	4.44	4.44	0.00	5.25	5.48	0.23
BaldheadShoalR1	2.04	2.33	0.29	2.53	2.91	0.38	2.94	3.40	0.46	3.31	3.77	0.46	3.94	4.31	0.37
BaldheadShoalR3	0.44	0.46	0.01	0.55	0.57	0.02	0.65	0.69	0.05	0.72	0.75	0.03	0.89	0.95	0.07

Current speed (ft/s) percentile at bottom layer for RSLR Medium projection, Flow Medium condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.44	0.44	0.00	0.54	0.54	0.00	0.57	0.57	0.00	0.58	0.58	0.00	0.60	0.61	0.01
CFR04	0.97	0.99	0.02	1.23	1.25	0.02	1.31	1.32	0.02	1.32	1.34	0.01	1.36	1.37	0.02
CFR03	1.02	1.02	0.00	1.16	1.16	0.00	1.28	1.27	-0.01	1.34	1.33	-0.01	1.41	1.41	0.00
CFR02	0.65	0.67	0.02	1.02	1.05	0.03	1.20	1.23	0.03	1.27	1.31	0.04	1.36	1.40	0.04
CFR01	0.65	0.65	0.00	0.99	1.00	0.01	1.21	1.21	0.00	1.25	1.25	0.00	1.30	1.31	0.01
NECF04	0.81	0.82	0.01	1.06	1.07	0.01	1.18	1.21	0.03	1.24	1.29	0.05	1.33	1.37	0.04
NECF03	0.82	0.83	0.01	1.70	1.72	0.02	1.98	2.03	0.04	2.06	2.15	0.09	2.24	2.32	0.07
NECF02	0.70	0.70	0.00	1.45	1.44	-0.01	1.73	1.80	0.07	1.84	1.90	0.07	1.99	2.10	0.11
NECF01	0.87	0.86	-0.01	1.19	1.17	-0.03	1.46	1.47	0.01	1.62	1.63	0.01	1.81	1.90	0.09
Battleship	1.65	1.73	0.07	2.36	2.49	0.13	2.74	2.91	0.17	2.84	3.04	0.20	3.02	3.25	0.23
LowerAnchorageBasin	0.23	0.15	-0.08	0.91	0.75	-0.16	1.36	1.24	-0.12	1.58	1.47	-0.11	2.05	2.08	0.03
LowerBigIsland	1.65	1.87	0.22	2.31	2.39	0.08	2.58	2.71	0.13	2.72	2.84	0.12	3.13	3.13	0.00
LowerLilliput	1.59	1.84	0.25	1.99	2.30	0.31	2.33	2.65	0.32	2.51	2.83	0.32	2.94	3.25	0.31
LowerMidnight	1.80	2.04	0.24	2.31	2.52	0.21	2.59	2.84	0.25	2.73	3.08	0.36	3.15	3.50	0.35
SnowMarsh	2.19	2.59	0.39	2.66	3.18	0.52	3.23	3.83	0.60	3.53	4.13	0.61	4.23	4.79	0.55
BatteryIsland	2.56	2.59	0.03	3.31	3.38	0.08	3.81	3.82	0.01	4.36	4.22	-0.13	5.15	5.10	-0.05
BaldheadShoalR1	2.11	2.37	0.26	2.57	2.92	0.35	2.96	3.42	0.46	3.24	3.83	0.60	3.83	4.45	0.62
BaldheadShoalR3	0.43	0.44	0.01	0.52	0.55	0.02	0.65	0.67	0.02	0.71	0.75	0.04	0.85	0.86	0.01

Current speed (ft/s) percentile at bottom layer for RSLR Medium projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.50	0.50	0.00	0.59	0.59	0.00	0.62	0.62	0.00	0.63	0.63	0.00	0.64	0.64	0.00
CFR04	0.99	1.00	0.01	1.29	1.30	0.00	1.36	1.37	0.01	1.38	1.39	0.01	1.41	1.43	0.02
CFR03	1.48	1.47	-0.01	1.56	1.56	0.00	1.59	1.59	0.00	1.60	1.60	0.00	1.61	1.61	0.00
CFR02	0.64	0.65	0.01	1.09	1.09	0.00	1.27	1.29	0.03	1.32	1.36	0.04	1.42	1.45	0.03
CFR01	0.69	0.69	0.00	0.94	0.94	0.00	1.04	1.05	0.00	1.08	1.08	0.00	1.13	1.13	0.00
NECF04	0.81	0.84	0.02	1.10	1.13	0.03	1.24	1.27	0.03	1.29	1.33	0.04	1.39	1.43	0.04
NECF03	1.09	1.10	0.01	1.85	1.86	0.01	2.14	2.17	0.03	2.21	2.25	0.05	2.37	2.41	0.05
NECF02	0.72	0.69	-0.03	1.75	1.80	0.05	2.04	2.07	0.03	2.16	2.20	0.04	2.38	2.40	0.02
NECF01	0.99	0.96	-0.04	1.39	1.35	-0.03	1.69	1.70	0.01	1.82	1.86	0.03	2.01	2.09	0.08
Battleship	1.60	1.67	0.07	2.45	2.57	0.12	2.76	2.99	0.23	3.01	3.16	0.15	3.42	3.43	0.01
LowerAnchorageBasin	0.20	0.15	-0.04	0.84	0.55	-0.29	1.30	1.18	-0.13	1.50	1.43	-0.07	1.93	1.86	-0.07
LowerBigIsland	1.59	1.85	0.26	2.26	2.40	0.14	2.55	2.71	0.17	2.70	2.87	0.16	3.14	3.07	-0.06
LowerLilliput	1.56	1.89	0.33	1.99	2.28	0.29	2.25	2.59	0.34	2.48	2.81	0.33	2.80	3.10	0.30
LowerMidnight	1.74	1.98	0.24	2.33	2.53	0.20	2.60	2.86	0.26	2.77	3.08	0.31	3.05	3.41	0.35
SnowMarsh	2.26	2.64	0.39	2.68	3.21	0.53	3.14	3.74	0.60	3.35	4.00	0.65	3.97	4.77	0.80
BatteryIsland	2.56	2.57	0.00	3.33	3.47	0.14	3.94	4.03	0.09	4.37	4.30	-0.07	5.23	4.70	-0.53
BaldheadShoalR1	2.09	2.39	0.30	2.63	2.96	0.33	2.99	3.39	0.41	3.29	3.87	0.58	3.72	4.37	0.65
BaldheadShoalR3	0.41	0.42	0.01	0.51	0.52	0.02	0.62	0.64	0.01	0.71	0.73	0.02	0.84	0.84	0.00

Current speed (ft/s) percentile at bottom layer for RSLR High projection, Flow Low condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.42	0.43	0.01	0.49	0.49	0.01	0.51	0.52	0.00	0.52	0.53	0.01	0.54	0.55	0.01
NECF04	1.10	1.12	0.02	1.19	1.22	0.03	1.27	1.29	0.03	1.32	1.35	0.03	1.48	1.51	0.03
CFR04	0.74	0.74	0.00	0.77	0.77	0.00	0.79	0.80	0.00	0.80	0.80	0.00	0.81	0.82	0.01
NECF03	0.70	0.72	0.02	0.89	0.91	0.02	1.09	1.12	0.03	1.15	1.18	0.03	1.24	1.27	0.04
CFR03	0.70	0.72	0.02	0.82	0.83	0.01	0.89	0.90	0.01	0.93	0.96	0.03	1.08	1.12	0.04
NECF02	0.81	0.81	-0.01	1.14	1.16	0.02	1.27	1.31	0.04	1.34	1.39	0.05	1.53	1.59	0.07
CFR02	0.89	0.91	0.02	1.35	1.40	0.06	1.62	1.67	0.05	1.71	1.75	0.04	1.84	1.90	0.07
CFR01	0.77	0.83	0.06	1.38	1.42	0.04	1.65	1.74	0.09	1.78	1.86	0.08	1.96	2.10	0.15
NECF01	0.95	0.99	0.04	1.23	1.30	0.06	1.47	1.53	0.06	1.60	1.66	0.07	1.81	1.87	0.05
Battleship	2.13	2.21	0.08	2.72	2.89	0.16	3.02	3.20	0.17	3.16	3.36	0.20	3.37	3.57	0.20
LowerAnchorageBasin	0.30	0.21	-0.09	1.22	1.06	-0.16	1.72	1.68	-0.04	1.89	1.94	0.05	2.29	2.39	0.10
LowerBigIsland	1.79	1.97	0.18	2.45	2.59	0.14	2.83	2.99	0.16	3.14	3.14	0.01	3.68	3.72	0.04
LowerLilliput	1.75	2.01	0.26	2.16	2.48	0.31	2.54	2.89	0.35	2.82	3.17	0.35	3.24	3.68	0.44
LowerMidnight	1.73	1.96	0.23	2.24	2.47	0.23	2.58	2.84	0.27	2.75	3.09	0.34	3.14	3.57	0.43
SnowMarsh	1.95	2.28	0.33	2.51	3.03	0.51	3.10	3.68	0.58	3.37	4.01	0.65	4.06	4.65	0.58
BatteryIsland	2.34	2.36	0.02	3.03	3.15	0.12	3.73	3.72	-0.01	4.24	4.34	0.10	5.12	5.38	0.26
BaldheadShoalR1	1.90	2.19	0.29	2.54	2.90	0.36	3.10	3.54	0.44	3.48	3.85	0.37	4.07	4.67	0.60
BaldheadShoalR3	0.47	0.51	0.04	0.59	0.63	0.04	0.70	0.74	0.05	0.81	0.89	0.08	0.96	1.23	0.27

Current speed (ft/s) percentile at bottom layer for RSLR High projection, Flow Medium condition

Flow	**50%**			**75%**			**90%**			**95%**			**99%**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.42	0.43	0.01	0.49	0.49	0.00	0.52	0.52	0.01	0.52	0.53	0.01	0.54	0.54	0.00
CFR04	1.13	1.15	0.02	1.22	1.25	0.03	1.29	1.32	0.03	1.32	1.35	0.03	1.43	1.50	0.07
CFR03	0.94	0.93	-0.01	1.04	1.04	0.00	1.07	1.07	0.00	1.08	1.08	0.00	1.08	1.09	0.00
CFR02	0.70	0.71	0.01	0.91	0.92	0.02	1.09	1.12	0.03	1.15	1.18	0.03	1.22	1.26	0.04
CFR01	0.68	0.69	0.02	0.81	0.82	0.02	0.85	0.86	0.01	0.87	0.89	0.02	0.97	1.00	0.03
NECF04	0.92	0.92	0.00	1.16	1.19	0.04	1.29	1.33	0.04	1.36	1.41	0.04	1.51	1.57	0.06
NECF03	0.91	0.90	0.00	1.44	1.47	0.03	1.67	1.71	0.04	1.75	1.79	0.04	1.86	1.91	0.06
NECF02	0.69	0.71	0.02	1.42	1.44	0.02	1.86	1.96	0.09	2.02	2.08	0.06	2.25	2.33	0.07
NECF01	0.94	0.99	0.05	1.30	1.32	0.02	1.53	1.57	0.04	1.66	1.73	0.08	1.86	1.95	0.10
Battleship	2.07	2.13	0.06	2.78	2.92	0.14	3.10	3.29	0.19	3.26	3.45	0.19	3.40	3.64	0.25
LowerAnchorageBasin	0.27	0.17	-0.11	1.13	0.94	-0.19	1.67	1.61	-0.06	1.90	1.87	-0.03	2.30	2.38	0.08
LowerBigIsland	1.74	1.98	0.24	2.49	2.64	0.15	2.87	3.04	0.17	3.05	3.24	0.19	3.58	3.80	0.22
LowerLilliput	1.73	2.01	0.28	2.14	2.47	0.33	2.48	2.84	0.36	2.71	3.09	0.37	3.20	3.64	0.44
LowerMidnight	1.72	1.99	0.27	2.28	2.47	0.19	2.58	2.85	0.27	2.76	3.06	0.30	3.09	3.58	0.49
SnowMarsh	2.00	2.34	0.34	2.50	2.97	0.47	3.01	3.64	0.62	3.29	3.95	0.65	4.01	4.63	0.62
BatteryIsland	2.38	2.48	0.10	3.12	3.20	0.08	3.58	3.63	0.05	4.11	4.03	-0.08	4.83	5.01	0.17
BaldheadShoalR1	2.01	2.27	0.27	2.55	2.91	0.35	3.03	3.48	0.46	3.38	3.94	0.55	3.89	4.41	0.53
BaldheadShoalR3	0.45	0.46	0.01	0.55	0.57	0.02	0.66	0.68	0.02	0.73	0.74	0.02	0.88	0.85	-0.03

Current speed (ft/s) percentile at bottom layer for RSLR High projection, Flow High condition

Flow	50%			75%			90%			95%			99%		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
BL01	0.44	0.44	0.00	0.51	0.52	0.01	0.54	0.54	0.00	0.54	0.55	0.00	0.55	0.55	0.00
CFR04	1.15	1.17	0.02	1.29	1.31	0.02	1.35	1.37	0.02	1.38	1.41	0.03	1.41	1.45	0.04
CFR03	1.19	1.17	-0.02	1.32	1.31	-0.01	1.38	1.37	-0.01	1.40	1.39	-0.01	1.43	1.43	0.00
CFR02	0.68	0.69	0.01	0.92	0.94	0.02	1.09	1.12	0.03	1.14	1.17	0.03	1.20	1.24	0.04
CFR01	0.64	0.65	0.01	0.81	0.82	0.01	0.86	0.87	0.01	0.88	0.89	0.01	0.90	0.91	0.02
NECF04	0.97	0.99	0.02	1.18	1.22	0.04	1.30	1.34	0.04	1.38	1.41	0.03	1.50	1.54	0.04
NECF03	1.03	1.06	0.02	1.55	1.57	0.01	1.73	1.77	0.04	1.79	1.83	0.04	1.89	1.94	0.05
NECF02	0.65	0.67	0.01	1.64	1.64	0.00	2.11	2.22	0.11	2.24	2.39	0.14	2.50	2.66	0.16
NECF01	1.03	1.00	-0.03	1.44	1.43	-0.01	1.72	1.73	0.01	1.87	1.89	0.02	2.08	2.16	0.07
Battleship	1.99	2.07	0.08	2.79	2.90	0.11	3.12	3.36	0.24	3.28	3.50	0.22	3.64	3.71	0.08
LowerAnchorageBasin	0.28	0.17	-0.11	1.05	0.77	-0.28	1.59	1.45	-0.14	1.87	1.82	-0.06	2.23	2.30	0.07
LowerBigIsland	1.64	1.95	0.31	2.46	2.63	0.17	2.93	3.09	0.15	3.05	3.31	0.25	3.62	3.60	-0.02
LowerLilliput	1.71	2.00	0.29	2.14	2.47	0.33	2.43	2.83	0.41	2.65	3.02	0.37	3.04	3.41	0.37
LowerMidnight	1.69	1.95	0.26	2.32	2.51	0.19	2.61	2.87	0.26	2.80	3.05	0.26	3.13	3.33	0.19
SnowMarsh	2.06	2.43	0.38	2.51	3.02	0.51	2.98	3.54	0.57	3.21	3.84	0.62	3.88	4.63	0.75
BatteryIsland	2.40	2.50	0.10	3.13	3.29	0.16	3.68	3.87	0.19	4.10	4.13	0.02	4.91	4.63	-0.28
BaldheadShoalR1	2.03	2.31	0.28	2.60	2.91	0.31	2.94	3.36	0.42	3.30	3.91	0.61	3.82	4.42	0.60
BaldheadShoalR3	0.42	0.43	0.01	0.53	0.55	0.02	0.65	0.67	0.02	0.73	0.77	0.04	0.89	0.87	-0.02

Appendix D–3:
Salinity

BL01 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NECF04 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CFR04 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NECF03 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CFR03 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NECF02 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.2	0.1	0.1	0.3	0.1	0.1	0.3	0.1
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Apr	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.3	0.1	0.2	0.4	0.2	0.2	0.4	0.2
May	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.5	0.7	0.2	0.7	1.0	0.3	0.7	1.0	0.3
Jun	0.2	0.3	0.1	0.2	0.4	0.2	0.3	0.4	0.2	0.3	0.5	0.2	0.4	0.6	0.2	0.4	0.7	0.3	1.0	1.4	0.4	1.3	1.8	0.5	1.4	1.9	0.5
Jul	0.2	0.3	0.1	0.3	0.4	0.2	0.3	0.4	0.2	0.3	0.5	0.2	0.4	0.6	0.2	0.4	0.7	0.3	1.0	1.4	0.4	1.4	1.9	0.5	1.4	2.0	0.5
Aug	0.2	0.3	0.1	0.2	0.4	0.2	0.2	0.4	0.2	0.3	0.5	0.2	0.4	0.6	0.2	0.4	0.6	0.2	1.0	1.3	0.4	1.3	1.8	0.5	1.4	1.9	0.5
Sep	0.2	0.3	0.1	0.2	0.4	0.2	0.2	0.4	0.2	0.3	0.5	0.2	0.4	0.6	0.2	0.4	0.6	0.3	1.0	1.4	0.4	1.3	1.8	0.5	1.4	1.9	0.5
Oct	0.2	0.3	0.1	0.2	0.4	0.2	0.3	0.4	0.2	0.3	0.5	0.2	0.4	0.6	0.2	0.4	0.7	0.3	1.0	1.4	0.4	1.3	1.9	0.5	1.4	2.0	0.6
Nov	0.2	0.3	0.1	0.2	0.4	0.2	0.3	0.4	0.2	0.3	0.5	0.2	0.4	0.6	0.2	0.4	0.7	0.3	1.0	1.4	0.4	1.3	1.8	0.5	1.4	1.9	0.5
Dec	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.1	0.3	0.5	0.2	0.3	0.6	0.2

CFR02 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CFR01 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.1	0.0	0.3	0.6	0.3	0.4	0.9	0.5	0.1	0.1	0.0	0.5	0.9	0.4	0.6	1.2	0.6	0.3	0.4	0.1	1.2	1.9	0.7	1.5	2.4	0.9
Feb	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.3	0.3	0.1	0.1	0.0	0.4	1.0	0.6	0.6	1.3	0.8
Mar	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.3	0.3	0.1	0.1	0.0	0.4	1.0	0.6	0.5	1.3	0.8
Apr	0.1	0.1	0.0	0.4	0.9	0.5	0.6	1.3	0.7	0.1	0.2	0.1	0.7	1.3	0.6	1.0	1.8	0.8	0.4	0.6	0.2	1.8	2.6	0.8	2.2	3.3	1.0
May	0.2	0.3	0.1	1.2	2.0	0.8	1.7	2.7	1.0	0.4	0.5	0.2	1.7	2.5	0.9	2.2	3.2	1.1	1.1	1.5	0.4	3.3	4.3	1.0	3.9	5.0	1.2
Jun	0.5	0.7	0.2	2.2	3.2	1.0	3.0	4.1	1.2	0.8	1.1	0.3	2.8	3.8	1.0	3.6	4.8	1.2	2.1	2.6	0.5	4.9	6.0	1.1	5.6	6.8	1.2
Jul	0.5	0.7	0.2	2.2	3.1	0.9	2.9	4.1	1.2	0.8	1.1	0.3	2.8	3.8	1.0	3.5	4.7	1.2	2.1	2.6	0.5	4.9	5.9	1.1	5.5	6.7	1.2
Aug	0.5	0.7	0.2	2.2	3.1	0.9	2.9	4.1	1.2	0.8	1.1	0.3	2.8	3.8	1.0	3.5	4.7	1.2	2.1	2.6	0.5	4.9	5.9	1.1	5.6	6.8	1.2
Sep	0.5	0.7	0.2	2.3	3.2	0.9	3.0	4.2	1.2	0.8	1.1	0.3	2.8	3.8	1.0	3.6	4.8	1.2	2.1	2.6	0.5	4.9	6.0	1.1	5.6	6.8	1.2
Oct	0.5	0.7	0.2	2.3	3.2	1.0	3.0	4.2	1.2	0.8	1.1	0.3	2.8	3.8	1.0	3.6	4.8	1.2	2.1	2.6	0.5	4.9	6.0	1.1	5.6	6.8	1.2
Nov	0.5	0.7	0.2	2.2	3.2	1.0	3.0	4.1	1.2	0.8	1.1	0.3	2.8	3.8	1.0	3.6	4.8	1.2	2.1	2.6	0.5	4.9	6.0	1.1	5.6	6.8	1.2
Dec	0.1	0.1	0.0	0.7	1.3	0.7	0.9	1.8	0.9	0.2	0.2	0.1	1.0	1.8	0.8	1.4	2.4	1.0	0.6	0.8	0.3	2.3	3.3	0.9	2.9	4.0	1.1

NECF01 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.6	1.1	0.5	1.5	2.9	1.5	1.6	3.3	1.7	0.8	1.4	0.6	1.9	3.5	1.6	2.1	3.9	1.8	1.9	2.8	0.8	3.5	5.3	1.8	3.7	5.6	1.9
Feb	0.2	0.5	0.3	0.4	1.6	1.2	0.5	1.9	1.4	0.3	0.7	0.4	0.7	2.1	1.4	0.8	2.5	1.6	1.0	1.7	0.7	2.0	3.8	1.8	2.2	4.2	2.0
Mar	0.2	0.5	0.3	0.4	1.5	1.2	0.5	1.8	1.4	0.3	0.7	0.4	0.7	2.1	1.4	0.8	2.4	1.6	1.0	1.6	0.7	2.0	3.8	1.8	2.2	4.1	2.0
Apr	0.9	1.6	0.7	2.2	4.0	1.8	2.4	4.5	2.1	1.2	1.9	0.7	2.8	4.6	1.9	3.0	5.2	2.1	2.6	3.5	0.9	4.7	6.5	1.8	5.0	6.9	2.0
May	2.0	2.9	0.9	4.1	6.1	2.0	4.5	6.7	2.2	2.4	3.3	0.9	4.8	6.8	2.0	5.2	7.4	2.2	4.3	5.4	1.1	7.0	8.8	1.8	7.3	9.2	1.9
Jun	3.3	4.4	1.1	6.0	8.0	2.0	6.5	8.7	2.2	3.8	5.0	1.1	6.8	8.8	2.0	7.3	9.4	2.1	6.3	7.5	1.2	9.2	11.0	1.7	9.6	11.4	1.8
Jul	3.3	4.3	1.1	5.9	7.9	2.0	6.4	8.6	2.2	3.8	4.9	1.1	6.7	8.6	1.9	7.2	9.3	2.1	6.3	7.5	1.2	9.2	10.9	1.7	9.5	11.3	1.8
Aug	3.2	4.3	1.1	6.0	8.0	2.0	6.5	8.7	2.2	3.8	4.9	1.1	6.7	8.7	2.0	7.2	9.3	2.1	6.2	7.4	1.2	9.2	10.9	1.7	9.6	11.4	1.8
Sep	3.3	4.4	1.1	6.0	8.1	2.0	6.6	8.8	2.2	3.8	5.0	1.1	6.8	8.8	2.0	7.3	9.5	2.1	6.3	7.5	1.2	9.3	11.0	1.7	9.7	11.5	1.8
Oct	3.3	4.4	1.1	6.1	8.1	2.0	6.6	8.8	2.2	3.9	5.0	1.1	6.8	8.8	2.0	7.3	9.5	2.2	6.3	7.6	1.2	9.3	11.0	1.7	9.6	11.4	1.8
Nov	3.3	4.4	1.1	6.0	8.0	2.0	6.5	8.7	2.2	3.8	5.0	1.1	6.8	8.8	2.0	7.3	9.4	2.1	6.3	7.5	1.2	9.2	11.0	1.7	9.6	11.4	1.8
Dec	1.3	2.0	0.8	2.9	4.9	2.0	3.3	5.5	2.2	1.6	2.4	0.8	3.6	5.6	2.0	3.9	6.2	2.3	3.3	4.3	1.0	5.7	7.5	1.8	6.0	7.9	2.0

Battleship — Salinity (ppt) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	1.1	1.8	0.7	3.6	6.6	3.0	6.2	10.6	4.5	1.3	2.0	0.7	4.3	7.3	3.0	7.2	11.4	4.3	2.3	3.1	0.8	6.3	9.0	2.6	9.3	12.8	3.5
Feb	0.4	0.9	0.6	1.7	4.8	3.1	3.9	9.0	5.1	0.6	1.2	0.6	2.4	5.6	3.2	5.0	9.9	4.9	1.3	2.0	0.7	4.4	7.4	3.0	7.4	11.5	4.1
Mar	0.4	0.9	0.6	1.7	4.8	3.1	3.9	9.0	5.1	0.5	1.1	0.6	2.3	5.5	3.2	5.0	9.9	4.9	1.2	1.9	0.7	4.4	7.4	3.0	7.4	11.5	4.2
Apr	1.5	2.4	0.8	5.1	8.4	3.3	8.3	12.7	4.4	1.9	2.7	0.8	6.0	9.1	3.1	9.3	13.4	4.1	3.1	3.9	0.9	8.1	10.6	2.5	11.3	14.5	3.2
May	3.0	3.9	1.0	7.8	10.8	3.0	11.0	14.8	3.8	3.4	4.4	1.0	8.6	11.5	2.8	11.9	15.4	3.5	5.0	6.0	1.0	10.6	12.9	2.2	13.6	16.4	2.7
Jun	4.5	5.7	1.1	10.2	12.9	2.7	13.2	16.5	3.3	5.1	6.2	1.2	11.0	13.5	2.5	14.0	17.0	3.0	7.0	8.2	1.1	13.0	15.0	2.0	15.7	18.1	2.4
Jul	4.5	5.7	1.1	10.1	12.8	2.7	13.1	16.3	3.3	5.1	6.2	1.2	10.9	13.4	2.5	13.9	16.8	2.9	7.0	8.2	1.1	12.9	14.9	2.0	15.6	17.9	2.3
Aug	4.5	5.6	1.1	10.2	12.9	2.7	13.2	16.5	3.3	5.0	6.2	1.1	11.0	13.5	2.5	14.0	16.9	3.0	7.0	8.1	1.1	13.0	15.0	2.0	15.7	18.1	2.3
Sep	4.5	5.7	1.1	10.3	13.0	2.7	13.3	16.6	3.3	5.1	6.2	1.1	11.1	13.6	2.5	14.1	17.1	3.0	7.0	8.2	1.1	13.1	15.1	2.0	15.8	18.2	2.4
Oct	4.6	5.7	1.1	10.3	13.0	2.7	13.3	16.6	3.3	5.1	6.3	1.2	11.1	13.6	2.5	14.0	17.0	3.0	7.1	8.2	1.1	13.0	15.1	2.0	15.8	18.1	2.4
Nov	4.5	5.7	1.1	10.2	12.9	2.7	13.2	16.5	3.3	5.1	6.2	1.2	11.0	13.5	2.5	14.0	17.0	3.0	7.0	8.2	1.1	13.0	15.0	2.0	15.7	18.1	2.4
Dec	2.1	3.0	0.9	6.4	9.6	3.2	9.7	13.7	4.0	2.4	3.3	0.9	7.2	10.2	3.0	10.6	14.4	3.7	3.8	4.7	0.9	9.3	11.6	2.3	12.4	15.3	2.9

LowerAnchorageBasin — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	1.5	2.3	0.9	6.1	10.6	4.5	10.8	16.0	5.2	1.8	2.6	0.9	7.1	11.4	4.3	12.1	16.8	4.7	2.8	3.7	0.9	9.4	13.0	3.5	14.7	18.4	3.7
Feb	0.6	1.4	0.7	3.7	8.7	5.0	9.0	15.1	6.1	0.9	1.6	0.8	4.9	9.6	4.8	10.5	16.0	5.5	1.7	2.5	0.8	7.6	11.7	4.1	13.6	17.9	4.3
Mar	0.6	1.3	0.7	3.7	8.7	5.0	9.1	15.2	6.1	0.8	1.6	0.8	4.8	9.6	4.8	10.6	16.1	5.5	1.7	2.4	0.8	7.5	11.7	4.1	13.6	17.9	4.3
Apr	2.0	3.1	1.0	8.1	12.7	4.5	12.8	17.4	4.6	2.4	3.4	1.0	9.2	13.4	4.2	14.0	18.1	4.2	3.6	4.6	1.0	11.4	14.7	3.3	16.2	19.5	3.3
May	3.6	4.8	1.2	11.0	14.9	3.9	14.9	18.7	3.8	4.1	5.3	1.2	11.8	15.5	3.7	15.8	19.3	3.5	5.6	6.7	1.1	13.7	16.6	2.8	17.8	20.6	2.8
Jun	5.3	6.7	1.4	13.4	16.7	3.3	16.6	19.8	3.3	5.9	7.2	1.4	14.1	17.2	3.1	17.3	20.4	3.0	7.7	8.9	1.2	15.9	18.3	2.4	19.3	21.7	2.4
Jul	5.3	6.7	1.4	13.2	16.5	3.3	16.5	19.7	3.3	5.9	7.2	1.4	14.0	17.0	3.1	17.3	20.3	3.0	7.7	8.9	1.2	15.8	18.1	2.3	19.2	21.6	2.4
Aug	5.3	6.6	1.4	13.4	16.7	3.3	16.6	19.9	3.3	5.8	7.2	1.3	14.1	17.2	3.1	17.4	20.4	3.0	7.6	8.8	1.2	15.9	18.3	2.4	19.3	21.7	2.4
Sep	5.3	6.7	1.4	13.5	16.8	3.3	16.6	19.9	3.3	5.9	7.2	1.4	14.2	17.3	3.1	17.4	20.4	3.0	7.7	8.9	1.2	16.0	18.3	2.4	19.4	21.8	2.4
Oct	5.4	6.7	1.4	13.4	16.7	3.3	16.6	19.9	3.3	5.9	7.3	1.4	14.1	17.3	3.1	17.4	20.4	3.0	7.7	8.9	1.2	15.9	18.3	2.4	19.3	21.7	2.4
Nov	5.3	6.7	1.4	13.4	16.7	3.3	16.5	19.8	3.3	5.9	7.2	1.4	14.1	17.2	3.1	17.3	20.4	3.0	7.7	8.9	1.2	15.9	18.3	2.4	19.3	21.7	2.4
Dec	2.6	3.8	1.1	9.6	13.8	4.3	13.9	18.0	4.1	3.0	4.1	1.1	10.5	14.5	4.0	14.9	18.6	3.8	4.4	5.4	1.0	12.5	15.5	3.0	16.9	19.9	3.0

LowerBigIsland — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	3.6	4.3	0.7	11.1	13.8	2.7	15.6	19.3	3.7	4.1	4.7	0.7	12.1	14.6	2.5	16.6	19.9	3.4	5.9	6.6	0.7	14.7	16.3	1.6	18.7	21.3	2.6
Feb	2.3	2.8	0.5	9.1	12.1	3.1	14.6	18.7	4.1	2.6	3.2	0.5	10.2	13.1	2.9	15.7	19.5	3.8	4.2	4.7	0.6	13.1	15.0	1.9	18.0	21.0	3.0
Mar	2.2	2.7	0.5	9.1	12.1	3.1	14.7	18.8	4.1	2.6	3.1	0.5	10.2	13.1	2.9	15.8	19.6	3.8	4.1	4.7	0.6	13.1	15.0	1.9	18.0	21.0	3.0
Apr	4.5	5.2	0.7	12.8	15.5	2.7	17.1	20.4	3.3	5.0	5.7	0.7	13.9	16.3	2.4	18.0	21.0	3.0	7.0	7.7	0.7	16.3	17.7	1.5	19.9	22.2	2.3
May	6.8	7.7	0.9	15.3	17.6	2.3	18.5	21.4	2.8	7.4	8.3	0.9	16.2	18.3	2.1	19.3	21.9	2.6	9.7	10.5	0.8	18.3	19.5	1.3	21.0	23.0	2.0
Jun	9.2	10.3	1.0	17.4	19.4	2.0	19.8	22.3	2.5	9.9	10.9	1.0	18.1	19.9	1.8	20.5	22.8	2.3	12.4	13.3	0.9	20.2	21.3	1.1	22.3	24.0	1.7
Jul	9.3	10.3	1.0	17.3	19.3	2.0	19.8	22.2	2.4	10.0	11.0	1.0	18.1	19.8	1.8	20.5	22.7	2.2	12.5	13.4	0.9	20.1	21.2	1.1	22.2	23.9	1.7
Aug	9.1	10.2	1.0	17.4	19.4	2.0	19.9	22.3	2.4	9.8	10.8	1.0	18.2	19.9	1.8	20.6	22.8	2.2	12.3	13.2	0.9	20.2	21.3	1.1	22.3	24.0	1.7
Sep	9.2	10.2	1.0	17.4	19.4	2.0	19.9	22.3	2.4	9.9	10.9	1.0	18.2	20.0	1.8	20.6	22.8	2.2	12.4	13.2	0.9	20.2	21.4	1.1	22.3	24.1	1.7
Oct	9.2	10.3	1.0	17.4	19.4	2.0	19.8	22.3	2.5	9.9	10.9	1.0	18.2	20.0	1.8	20.5	22.8	2.3	12.4	13.3	0.9	20.2	21.3	1.1	22.3	24.0	1.7
Nov	9.2	10.3	1.0	17.4	19.4	2.0	19.8	22.3	2.5	9.9	10.9	1.0	18.1	19.9	1.8	20.5	22.7	2.3	12.4	13.3	0.9	20.2	21.3	1.1	22.3	24.0	1.7
Dec	5.4	6.2	0.8	14.1	16.5	2.5	17.8	20.8	3.0	6.0	6.8	0.8	15.0	17.3	2.2	18.6	21.4	2.8	8.1	8.9	0.7	17.2	18.5	1.3	20.4	22.5	2.1

LowerLilliput — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.0	7.8	0.8	18.0	20.0	2.1	21.4	23.8	2.3	7.7	8.4	0.7	19.0	20.9	1.9	22.1	24.3	2.1	9.8	10.4	0.7	20.9	22.1	1.3	23.7	25.4	1.7
Feb	5.2	5.9	0.7	16.6	18.8	2.2	21.0	23.5	2.5	5.8	6.5	0.6	17.8	19.8	2.0	21.8	24.1	2.3	7.8	8.4	0.6	20.0	21.4	1.4	23.4	25.3	1.9
Mar	5.1	5.8	0.6	16.6	18.8	2.2	21.1	23.6	2.5	5.8	6.4	0.6	17.8	19.8	2.0	21.9	24.1	2.3	7.7	8.3	0.6	20.0	21.4	1.4	23.5	25.4	1.8
Apr	8.2	9.0	0.8	19.5	21.5	2.0	22.3	24.4	2.1	8.9	9.6	0.7	20.4	22.2	1.8	22.9	24.8	1.9	11.0	11.7	0.7	22.0	23.2	1.1	24.4	25.9	1.5
May	10.8	11.7	0.9	21.1	22.9	1.7	23.1	24.9	1.8	11.6	12.4	0.8	21.9	23.5	1.6	23.7	25.3	1.7	13.8	14.5	0.7	23.3	24.3	1.0	25.1	26.4	1.3
Jun	13.4	14.4	0.9	22.5	24.0	1.5	23.9	25.5	1.6	14.2	15.0	0.9	23.1	24.4	1.3	24.4	25.9	1.5	16.5	17.3	0.8	24.5	25.4	1.0	25.9	27.1	1.2
Jul	13.5	14.5	0.9	22.5	23.9	1.5	23.9	25.5	1.6	14.3	15.2	0.9	23.1	24.4	1.3	24.4	25.9	1.5	16.6	17.4	0.8	24.4	25.4	1.0	25.8	27.1	1.2
Aug	13.4	14.3	0.9	22.5	24.0	1.5	24.0	25.5	1.6	14.1	15.0	0.9	23.1	24.5	1.3	24.5	25.9	1.5	16.5	17.2	0.8	24.5	25.4	0.9	25.9	27.1	1.2
Sep	13.4	14.3	0.9	22.6	24.0	1.5	24.0	25.6	1.6	14.1	15.0	0.9	23.2	24.5	1.3	24.5	26.0	1.5	16.5	17.2	0.8	24.5	25.5	1.0	25.9	27.1	1.2
Oct	13.4	14.4	0.9	22.5	24.0	1.5	23.9	25.5	1.6	14.2	15.1	0.9	23.1	24.4	1.3	24.4	25.9	1.5	16.5	17.3	0.8	24.5	25.4	1.0	25.9	27.1	1.2
Nov	13.4	14.4	0.9	22.5	23.9	1.5	23.9	25.5	1.6	14.2	15.1	0.9	23.1	24.4	1.3	24.4	25.9	1.5	16.5	17.3	0.8	24.5	25.4	1.0	25.9	27.1	1.2
Dec	9.3	10.2	0.9	20.3	22.2	1.8	22.6	24.6	2.0	10.1	10.9	0.8	21.2	22.8	1.7	23.2	25.0	1.8	12.3	13.0	0.7	22.6	23.6	1.1	24.6	26.0	1.4

LowerMidnight — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.9	11.6	0.8	23.0	24.2	1.1	26.5	27.8	1.4	11.5	12.3	0.7	23.9	24.9	1.0	27.0	28.2	1.2	13.9	14.6	0.8	25.8	26.4	0.6	28.2	29.1	0.9
Feb	8.8	9.5	0.8	22.3	23.5	1.3	26.4	27.8	1.4	9.4	10.1	0.8	23.3	24.4	1.1	26.9	28.2	1.3	11.6	12.4	0.8	25.4	26.1	0.8	28.2	29.2	1.0
Mar	8.7	9.4	0.8	22.3	23.6	1.2	26.4	27.8	1.4	9.3	10.0	0.7	23.3	24.5	1.1	27.0	28.3	1.3	11.5	12.3	0.8	25.4	26.2	0.8	28.3	29.3	1.0
Apr	12.2	12.9	0.8	23.9	25.0	1.0	26.8	28.1	1.3	12.9	13.6	0.7	24.8	25.7	0.9	27.3	28.5	1.2	15.2	16.0	0.8	26.5	27.1	0.5	28.5	29.3	0.9
May	15.0	15.8	0.7	25.0	25.9	0.9	27.2	28.3	1.2	15.8	16.5	0.7	25.7	26.5	0.8	27.6	28.6	1.1	18.2	18.9	0.8	27.2	27.7	0.5	28.7	29.5	0.8
Jun	17.9	18.5	0.7	26.0	26.7	0.8	27.6	28.6	1.0	18.6	19.3	0.6	26.5	27.2	0.7	28.0	28.9	1.0	21.0	21.7	0.7	28.1	28.6	0.5	29.2	30.0	0.7
Jul	18.1	18.7	0.7	26.0	26.7	0.7	27.6	28.6	1.0	18.8	19.4	0.7	26.6	27.2	0.7	28.0	28.9	0.9	21.2	21.9	0.7	28.1	28.6	0.5	29.3	30.0	0.7
Aug	17.8	18.5	0.6	26.0	26.7	0.7	27.6	28.6	1.0	18.6	19.2	0.6	26.6	27.3	0.7	28.0	28.9	0.9	21.0	21.7	0.7	28.1	28.6	0.5	29.3	30.0	0.7
Sep	17.8	18.5	0.6	26.0	26.8	0.8	27.6	28.6	1.0	18.6	19.2	0.6	26.6	27.3	0.7	28.0	28.9	1.0	21.0	21.7	0.7	28.1	28.6	0.5	29.3	30.0	0.7
Oct	17.9	18.5	0.7	26.0	26.7	0.8	27.6	28.6	1.0	18.6	19.3	0.6	26.5	27.2	0.7	27.9	28.9	1.0	21.0	21.7	0.7	28.1	28.6	0.5	29.2	30.0	0.7
Nov	17.9	18.5	0.7	26.0	26.7	0.8	27.6	28.6	1.0	18.6	19.3	0.6	26.5	27.2	0.7	28.0	28.9	1.0	21.0	21.7	0.7	28.1	28.6	0.5	29.2	30.0	0.7
Dec	13.5	14.2	0.8	24.4	25.4	1.0	26.9	28.2	1.3	14.2	14.9	0.7	25.2	26.0	0.8	27.4	28.5	1.1	16.6	17.3	0.8	26.8	27.3	0.5	28.5	29.3	0.8

SnowMarsh — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	18.2	18.9	0.7	28.0	28.4	0.4	30.3	31.1	0.8	18.6	19.2	0.6	28.5	28.8	0.3	30.6	31.3	0.7	20.0	20.7	0.6	29.5	29.6	0.1	31.4	31.8	0.5
Feb	16.0	16.6	0.6	27.6	28.0	0.4	30.2	31.1	0.9	16.4	17.0	0.6	28.1	28.5	0.3	30.6	31.3	0.8	17.8	18.5	0.7	29.3	29.4	0.1	31.3	31.8	0.5
Mar	15.9	16.5	0.6	27.6	28.0	0.4	30.3	31.1	0.9	16.3	16.9	0.6	28.2	28.5	0.3	30.6	31.4	0.8	17.7	18.4	0.7	29.4	29.5	0.1	31.4	31.9	0.5
Apr	19.4	20.1	0.6	28.5	28.8	0.4	30.6	31.3	0.7	19.8	20.4	0.6	28.9	29.2	0.3	30.8	31.5	0.7	21.2	21.8	0.6	29.9	30.0	0.1	31.6	32.0	0.4
May	22.0	22.7	0.7	29.0	29.4	0.3	30.7	31.4	0.7	22.4	23.0	0.6	29.4	29.7	0.3	31.0	31.6	0.6	23.8	24.3	0.5	30.4	30.5	0.1	31.7	32.1	0.4
Jun	24.4	25.0	0.6	29.7	30.0	0.3	30.9	31.5	0.6	24.7	25.3	0.6	30.0	30.2	0.3	31.1	31.7	0.5	26.1	26.6	0.5	31.1	31.3	0.2	32.1	32.4	0.3
Jul	24.5	25.1	0.6	29.7	30.0	0.3	30.9	31.5	0.6	24.9	25.5	0.6	30.0	30.3	0.3	31.2	31.7	0.5	26.2	26.7	0.5	31.1	31.3	0.2	32.1	32.4	0.3
Aug	24.4	25.0	0.6	29.7	30.0	0.3	31.0	31.6	0.6	24.7	25.3	0.6	30.0	30.3	0.3	31.2	31.7	0.5	26.1	26.6	0.5	31.1	31.3	0.2	32.1	32.4	0.3
Sep	24.3	25.0	0.6	29.7	30.0	0.3	31.0	31.6	0.6	24.7	25.3	0.6	30.0	30.3	0.3	31.2	31.7	0.5	26.1	26.5	0.5	31.1	31.3	0.2	32.1	32.4	0.3
Oct	24.4	25.0	0.6	29.7	30.0	0.3	30.9	31.5	0.6	24.7	25.3	0.6	30.0	30.2	0.3	31.1	31.7	0.6	26.1	26.6	0.5	31.1	31.3	0.2	32.1	32.4	0.3
Nov	24.4	25.0	0.6	29.7	29.9	0.3	30.9	31.5	0.6	24.7	25.3	0.6	30.0	30.2	0.3	31.1	31.7	0.5	26.1	26.6	0.5	31.1	31.3	0.2	32.1	32.4	0.3
Dec	20.7	21.4	0.7	28.7	29.0	0.4	30.6	31.3	0.7	21.1	21.7	0.6	29.1	29.4	0.3	30.9	31.5	0.6	22.5	23.1	0.6	30.0	30.1	0.1	31.6	32.0	0.4

BatteryIsland — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	22.2	22.5	0.2	29.2	29.4	0.2	31.3	31.9	0.6	22.8	22.9	0.2	29.5	29.7	0.2	31.5	32.0	0.6	24.4	24.5	0.1	30.3	30.3	0.0	32.1	32.4	0.3
Feb	20.5	20.6	0.1	28.9	28.9	0.0	31.2	31.9	0.6	21.0	21.1	0.1	29.2	29.3	0.1	31.5	32.0	0.6	22.7	22.7	0.0	30.1	30.1	-0.1	32.1	32.4	0.3
Mar	20.4	20.5	0.1	28.9	28.9	0.0	31.3	31.9	0.6	20.9	21.0	0.1	29.2	29.3	0.1	31.5	32.1	0.6	22.6	22.7	0.0	30.2	30.1	-0.1	32.1	32.5	0.3
Apr	23.3	23.5	0.2	29.6	29.8	0.2	31.5	32.1	0.6	23.8	24.0	0.2	29.9	30.1	0.2	31.7	32.2	0.5	25.3	25.4	0.1	30.7	30.7	0.0	32.3	32.5	0.3
May	25.4	25.7	0.3	30.0	30.4	0.3	31.6	32.2	0.5	25.8	26.1	0.2	30.3	30.6	0.3	31.8	32.3	0.5	27.2	27.4	0.2	31.1	31.2	0.1	32.4	32.7	0.3
Jun	27.2	27.5	0.3	30.6	30.9	0.3	31.8	32.3	0.5	27.7	27.9	0.2	30.8	31.0	0.2	32.0	32.4	0.4	29.0	29.2	0.2	31.7	31.7	0.0	32.7	33.0	0.2
Jul	27.4	27.7	0.3	30.6	30.9	0.3	31.8	32.3	0.5	27.8	28.0	0.2	30.8	31.1	0.2	32.0	32.4	0.4	29.1	29.3	0.2	31.7	31.7	0.0	32.7	33.0	0.2
Aug	27.2	27.5	0.3	30.6	30.9	0.3	31.9	32.3	0.5	27.7	27.9	0.2	30.8	31.1	0.2	32.0	32.4	0.4	29.0	29.2	0.2	31.7	31.7	0.0	32.7	33.0	0.2
Sep	27.2	27.5	0.3	30.6	30.9	0.3	31.9	32.3	0.5	27.6	27.9	0.2	30.8	31.1	0.3	32.0	32.4	0.4	29.0	29.2	0.2	31.7	31.7	0.0	32.7	33.0	0.2
Oct	27.2	27.5	0.3	30.6	30.9	0.3	31.8	32.3	0.5	27.6	27.9	0.2	30.8	31.0	0.2	31.9	32.4	0.4	29.0	29.2	0.2	31.7	31.7	0.0	32.7	33.0	0.2
Nov	27.3	27.5	0.3	30.6	30.9	0.3	31.8	32.3	0.5	27.7	27.9	0.2	30.8	31.0	0.2	32.0	32.4	0.4	29.0	29.2	0.2	31.7	31.7	0.0	32.7	33.0	0.2
Dec	24.3	24.6	0.3	29.8	30.1	0.3	31.5	32.1	0.6	24.8	25.0	0.2	30.0	30.3	0.3	31.7	32.2	0.5	26.3	26.4	0.1	30.8	30.9	0.1	32.3	32.5	0.3

BaldheadShoalR1 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	26.3	26.4	0.2	32.5	32.5	0.0	33.5	33.7	0.2	26.8	26.9	0.1	32.6	32.5	0.0	33.5	33.7	0.2	28.2	28.3	0.1	32.8	32.8	-0.1	33.6	33.8	0.2
Feb	24.5	24.7	0.2	32.5	32.5	0.0	33.6	33.8	0.2	25.2	25.3	0.1	32.6	32.5	0.0	33.6	33.8	0.2	26.8	26.9	0.1	32.8	32.8	-0.1	33.8	33.9	0.2
Mar	24.4	24.6	0.2	32.5	32.5	0.0	33.6	33.8	0.2	25.1	25.2	0.1	32.6	32.6	0.0	33.6	33.9	0.2	26.7	26.8	0.1	32.9	32.8	-0.1	33.8	34.0	0.2
Apr	27.1	27.3	0.1	32.6	32.6	0.0	33.6	33.7	0.2	27.6	27.7	0.1	32.7	32.7	0.0	33.6	33.8	0.2	28.9	29.0	0.0	33.0	32.9	-0.1	33.8	33.9	0.1
May	29.0	29.0	0.1	32.8	32.7	0.0	33.5	33.6	0.2	29.3	29.4	0.0	32.8	32.8	0.0	33.5	33.7	0.2	30.5	30.5	0.0	33.2	33.2	0.0	33.8	33.9	0.1
Jun	30.5	30.5	0.0	33.0	33.0	0.0	33.4	33.6	0.2	30.8	30.8	0.0	33.1	33.1	0.0	33.5	33.6	0.1	31.9	31.9	0.0	33.6	33.6	0.0	33.9	34.0	0.1
Jul	30.6	30.6	0.0	33.0	33.0	0.0	33.4	33.6	0.2	30.9	30.9	0.0	33.1	33.1	0.0	33.5	33.6	0.1	32.0	32.0	0.0	33.6	33.6	0.0	34.0	34.0	0.1
Aug	30.5	30.5	0.0	33.0	33.0	0.0	33.5	33.6	0.2	30.8	30.8	0.0	33.1	33.1	0.0	33.5	33.6	0.1	31.9	31.9	0.0	33.6	33.6	0.0	34.0	34.0	0.1
Sep	30.5	30.5	0.0	33.0	33.0	0.0	33.4	33.6	0.2	30.8	30.8	0.0	33.1	33.1	0.0	33.5	33.6	0.1	31.9	31.9	0.0	33.6	33.6	0.0	33.9	34.0	0.1
Oct	30.5	30.5	0.0	33.0	33.0	0.0	33.4	33.6	0.2	30.8	30.8	0.0	33.1	33.1	0.0	33.5	33.6	0.1	31.9	31.9	0.0	33.6	33.6	0.0	33.9	34.0	0.1
Nov	30.5	30.5	0.0	33.0	33.0	0.0	33.4	33.6	0.2	30.8	30.8	0.0	33.1	33.1	0.0	33.5	33.6	0.1	31.9	31.9	0.0	33.6	33.6	0.0	33.9	34.0	0.1
Dec	28.2	28.3	0.1	32.7	32.6	0.0	33.5	33.7	0.2	28.6	28.6	0.1	32.7	32.7	0.0	33.5	33.7	0.2	29.8	29.8	0.0	33.0	33.0	0.0	33.7	33.8	0.1

BaldheadShoalR3 — Salinity (ppt) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	31.0	31.2	0.2	35.0	34.9	0.0	35.0	35.0	0.0	31.2	31.3	0.2	35.0	35.0	0.0	35.0	35.0	0.0	31.8	31.8	0.1	35.1	35.0	0.0	35.1	35.1	0.0
Feb	30.3	30.6	0.3	35.0	34.9	0.0	35.0	35.0	0.0	30.5	30.7	0.2	35.0	35.0	0.0	35.0	35.0	0.0	31.2	31.3	0.1	35.1	35.0	0.0	35.1	35.1	0.0
Mar	30.3	30.6	0.3	35.0	34.9	0.0	35.0	35.0	0.0	30.5	30.7	0.2	35.0	35.0	0.0	35.0	35.0	0.0	31.2	31.3	0.1	35.1	35.0	0.0	35.1	35.1	0.0
Apr	31.2	31.4	0.2	35.0	35.0	0.0	35.0	35.0	0.0	31.4	31.6	0.1	35.0	35.0	0.0	35.0	35.0	0.0	32.1	32.1	0.0	35.1	35.1	0.0	35.1	35.1	0.0
May	31.9	32.0	0.1	35.0	34.9	0.0	35.0	35.0	0.0	32.1	32.2	0.1	35.0	35.0	0.0	35.0	35.0	0.0	32.9	32.8	0.0	35.1	35.0	0.0	35.1	35.1	0.0
Jun	32.6	32.6	0.1	34.9	34.9	0.0	35.0	35.0	0.0	32.7	32.7	0.0	35.0	34.9	0.0	35.0	35.0	0.0	33.8	33.8	-0.1	35.0	35.0	-0.1	35.1	35.1	0.0
Jul	32.6	32.7	0.0	34.9	34.9	0.0	35.0	35.0	0.0	32.7	32.8	0.0	34.9	34.9	-0.1	35.0	35.0	0.0	33.8	33.8	-0.1	35.0	35.0	-0.1	35.1	35.1	0.0
Aug	32.6	32.6	0.0	34.9	34.9	0.0	35.0	35.0	0.0	32.7	32.7	0.0	35.0	34.9	0.0	35.0	35.0	0.0	33.8	33.8	-0.1	35.0	35.0	-0.1	35.1	35.1	0.0
Sep	32.6	32.6	0.0	34.9	34.9	0.0	35.0	35.0	0.0	32.7	32.7	0.0	35.0	34.9	0.0	35.0	35.0	0.0	33.8	33.7	-0.1	35.0	35.0	-0.1	35.1	35.1	0.0
Oct	32.5	32.6	0.1	34.9	34.9	0.0	35.0	35.0	0.0	32.7	32.7	0.0	35.0	34.9	0.0	35.0	35.0	0.0	33.8	33.7	-0.1	35.0	35.0	-0.1	35.1	35.1	0.0
Nov	32.6	32.6	0.1	34.9	34.9	0.0	35.0	35.0	0.0	32.7	32.7	0.0	35.0	34.9	0.0	35.0	35.0	0.0	33.8	33.7	-0.1	35.0	35.0	-0.1	35.1	35.1	0.0
Dec	31.6	31.8	0.2	35.0	35.0	0.0	35.0	35.0	0.0	31.8	31.9	0.1	35.0	35.0	0.0	35.0	35.0	0.0	32.5	32.4	0.0	35.1	35.1	0.0	35.1	35.1	0.0

BL01 — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NECF04 — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CFR04 — Salinity (ppt) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NECF03 — Salinity (ppt) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.4	0.5	0.1	0.4	0.6	0.1	0.4	0.6	0.1
Jul	0.8	1.1	0.3	0.9	1.2	0.3	0.9	1.2	0.3
Aug	0.3	0.4	0.1	0.3	0.4	0.1	0.3	0.4	0.1
Sep	0.4	0.5	0.1	0.4	0.6	0.1	0.4	0.6	0.1
Oct	0.7	0.9	0.2	0.7	1.0	0.2	0.7	1.0	0.2
Nov	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CFR03 — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NECF02 — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	1.0	1.4	0.3	1.3	1.7	0.4	1.4	1.9	0.5
Feb	0.2	0.3	0.1	0.2	0.4	0.2	0.3	0.4	0.2
Mar	0.2	0.3	0.1	0.2	0.4	0.2	0.2	0.4	0.2
Apr	0.2	0.3	0.1	0.2	0.4	0.2	0.2	0.4	0.2
May	0.9	1.3	0.3	1.2	1.6	0.4	1.3	1.7	0.5
Jun	3.0	3.6	0.6	3.5	4.1	0.7	3.7	4.3	0.7
Jul	5.1	5.9	0.8	5.7	6.6	0.9	6.0	6.9	0.9
Aug	2.6	3.1	0.5	3.0	3.6	0.6	3.2	3.8	0.6
Sep	3.0	3.6	0.6	3.4	4.1	0.7	3.6	4.3	0.7
Oct	4.3	5.1	0.7	4.9	5.7	0.8	5.2	6.0	0.8
Nov	1.2	1.5	0.3	1.4	1.8	0.4	1.5	1.9	0.4
Dec	0.6	0.9	0.2	0.8	1.1	0.3	0.9	1.2	0.4

CFR02 — Salinity (ppt) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Jul	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Oct	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.1
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CFR01 — Salinity (ppt) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	2.9	3.5	0.6	5.7	6.8	1.1	6.9	8.0	1.2
Feb	0.5	0.7	0.2	2.2	3.2	1.0	3.0	4.1	1.2
Mar	0.5	0.7	0.2	2.2	3.2	0.9	2.9	4.1	1.2
Apr	0.5	0.7	0.2	2.3	3.2	0.9	3.0	4.2	1.2
May	2.7	3.2	0.6	5.4	6.5	1.1	6.6	7.8	1.2
Jun	4.9	5.7	0.7	8.2	9.3	1.0	9.5	10.6	1.1
Jul	6.9	7.8	0.8	10.5	11.4	1.0	11.8	12.7	0.9
Aug	4.5	5.2	0.7	7.8	8.8	1.0	9.1	10.1	1.0
Sep	4.9	5.7	0.7	8.3	9.3	1.0	9.5	10.6	1.1
Oct	6.2	7.0	0.8	9.7	10.7	1.0	11.0	12.0	1.0
Nov	2.4	2.9	0.5	5.0	6.0	1.0	6.0	7.1	1.1
Dec	1.8	2.2	0.4	4.1	5.1	1.0	5.1	6.3	1.2

NECF01 — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.2	8.4	1.2	10.4	12.1	1.7	11.0	12.8	1.7
Feb	3.3	4.4	1.1	6.0	8.0	2.0	6.5	8.7	2.2
Mar	3.2	4.3	1.1	6.0	8.0	2.0	6.5	8.7	2.2
Apr	3.3	4.4	1.1	6.1	8.1	2.0	6.6	8.8	2.2
May	6.9	8.1	1.2	10.2	11.9	1.7	10.8	12.6	1.8
Jun	10.3	11.5	1.2	13.3	14.7	1.5	13.8	15.3	1.5
Jul	13.2	14.5	1.3	15.7	17.0	1.3	16.1	17.4	1.3
Aug	9.7	10.9	1.2	12.8	14.3	1.5	13.3	14.9	1.5
Sep	10.3	11.5	1.2	13.3	14.8	1.5	13.8	15.4	1.5
Oct	12.2	13.5	1.3	14.9	16.3	1.4	15.3	16.7	1.4
Nov	6.4	7.5	1.2	9.4	11.2	1.8	10.0	11.8	1.9
Dec	5.4	6.5	1.2	8.4	10.3	1.8	9.0	11.0	2.0

Battleship — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.5	10.8	1.3	14.8	16.9	2.1	17.1	19.5	2.3
Feb	4.5	5.7	1.1	10.2	12.9	2.7	13.2	16.5	3.3
Mar	4.5	5.6	1.1	10.2	12.9	2.7	13.2	16.6	3.3
Apr	4.5	5.7	1.1	10.3	13.0	2.7	13.3	16.6	3.3
May	9.1	10.4	1.3	14.6	16.7	2.2	17.0	19.5	2.5
Jun	12.5	13.8	1.3	17.3	19.1	1.8	19.3	21.2	1.9
Jul	15.2	16.5	1.3	19.4	20.9	1.5	21.0	22.5	1.5
Aug	12.0	13.3	1.3	16.9	18.7	1.8	19.0	21.0	2.0
Sep	12.5	13.8	1.3	17.4	19.2	1.8	19.3	21.3	1.9
Oct	14.3	15.6	1.3	18.7	20.3	1.6	20.4	22.1	1.7
Nov	8.3	9.5	1.3	13.6	15.9	2.2	16.1	18.8	2.6
Dec	7.2	8.5	1.2	12.8	15.1	2.4	15.4	18.2	2.8

LowerAnchorageBasin — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.3	11.7	1.4	17.4	19.7	2.4	19.8	22.1	2.3
Feb	5.3	6.7	1.4	13.4	16.7	3.3	16.6	19.8	3.3
Mar	5.3	6.6	1.3	13.4	16.7	3.3	16.6	19.9	3.3
Apr	5.3	6.7	1.4	13.5	16.8	3.3	16.6	19.9	3.3
May	9.9	11.3	1.4	17.2	19.7	2.5	19.6	22.0	2.5
Jun	13.2	14.6	1.4	19.5	21.5	2.0	21.5	23.5	1.9
Jul	16.0	17.3	1.3	21.2	22.8	1.6	23.0	24.5	1.5
Aug	12.7	14.1	1.4	19.2	21.2	2.0	21.3	23.3	2.0
Sep	13.2	14.6	1.4	19.6	21.5	2.0	21.6	23.5	1.9
Oct	15.0	16.4	1.4	20.6	22.3	1.8	22.4	24.1	1.7
Nov	9.0	10.4	1.4	16.3	19.0	2.6	18.9	21.5	2.6
Dec	8.0	9.4	1.4	15.6	18.4	2.8	18.3	21.1	2.8

LowerBigIsland — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	15.1	16.2	1.1	21.0	22.4	1.4	22.6	24.3	1.7
Feb	9.2	10.2	1.0	17.4	19.4	2.0	19.8	22.3	2.4
Mar	9.1	10.2	1.0	17.4	19.4	2.0	19.9	22.3	2.4
Apr	9.2	10.2	1.0	17.4	19.4	2.0	19.9	22.3	2.4
May	14.6	15.6	1.1	20.8	22.3	1.5	22.4	24.3	1.8
Jun	18.0	19.1	1.0	22.9	24.1	1.2	24.1	25.6	1.4
Jul	20.7	21.7	1.0	24.5	25.4	1.0	25.4	26.6	1.2
Aug	17.6	18.6	1.0	22.7	23.8	1.2	24.0	25.4	1.5
Sep	18.0	19.0	1.0	23.0	24.1	1.2	24.2	25.6	1.4
Oct	19.7	20.7	1.0	23.9	25.0	1.1	24.9	26.2	1.3
Nov	13.5	14.5	1.0	20.1	21.6	1.6	21.9	23.8	1.9
Dec	12.4	13.4	1.0	19.4	21.1	1.7	21.4	23.4	2.1

LowerLilliput — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	19.3	20.1	0.8	25.1	26.1	1.0	26.1	27.3	1.2
Feb	13.4	14.4	0.9	22.5	24.0	1.5	23.9	25.5	1.6
Mar	13.4	14.3	0.9	22.5	24.0	1.5	24.0	25.6	1.6
Apr	13.4	14.3	0.9	22.5	24.0	1.5	24.0	25.5	1.6
May	18.7	19.5	0.8	24.9	25.9	1.1	25.9	27.1	1.2
Jun	21.9	22.7	0.7	26.4	27.3	0.8	27.3	28.2	1.0
Jul	24.4	25.1	0.7	27.6	28.3	0.7	28.3	29.1	0.8
Aug	21.5	22.2	0.7	26.3	27.1	0.9	27.1	28.1	1.0
Sep	21.9	22.6	0.7	26.5	27.3	0.8	27.3	28.3	1.0
Oct	23.4	24.1	0.7	27.2	27.9	0.7	27.9	28.7	0.9
Nov	17.6	18.4	0.8	24.4	25.5	1.2	25.5	26.8	1.3
Dec	16.5	17.4	0.9	23.9	25.1	1.2	25.1	26.5	1.4

LowerMidnight — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	23.5	24.1	0.7	28.4	28.8	0.4	29.3	30.0	0.6
Feb	17.9	18.6	0.7	26.0	26.7	0.7	27.6	28.6	1.0
Mar	17.8	18.4	0.6	26.0	26.8	0.7	27.6	28.6	1.0
Apr	17.9	18.5	0.6	26.0	26.8	0.8	27.6	28.6	1.0
May	22.8	23.5	0.7	28.1	28.6	0.5	29.1	29.8	0.7
Jun	25.6	26.2	0.6	29.5	29.9	0.4	30.2	30.7	0.5
Jul	27.7	28.2	0.6	30.5	30.8	0.3	31.0	31.5	0.5
Aug	25.3	25.9	0.6	29.4	29.7	0.4	30.1	30.6	0.6
Sep	25.6	26.2	0.6	29.5	29.9	0.4	30.2	30.7	0.5
Oct	26.9	27.4	0.6	30.1	30.4	0.4	30.7	31.1	0.5
Nov	21.7	22.4	0.6	27.7	28.2	0.6	28.8	29.6	0.8
Dec	20.8	21.5	0.7	27.3	27.9	0.6	28.5	29.3	0.8

SnowMarsh — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	28.6	29.0	0.4	31.3	31.5	0.2	31.8	32.2	0.4
Feb	24.4	25.0	0.6	29.7	30.0	0.3	31.0	31.5	0.6
Mar	24.3	25.0	0.6	29.7	30.0	0.3	31.0	31.6	0.6
Apr	24.4	25.0	0.6	29.7	30.0	0.3	31.0	31.5	0.6
May	28.1	28.5	0.4	31.1	31.3	0.2	31.7	32.1	0.4
Jun	30.0	30.3	0.3	31.9	32.1	0.2	32.3	32.6	0.3
Jul	31.3	31.6	0.3	32.6	32.7	0.2	32.8	33.0	0.2
Aug	29.8	30.2	0.3	31.9	32.1	0.2	32.3	32.6	0.3
Sep	30.0	30.3	0.3	32.0	32.1	0.2	32.3	32.6	0.3
Oct	30.8	31.1	0.3	32.3	32.5	0.2	32.6	32.8	0.3
Nov	27.2	27.7	0.5	30.8	31.0	0.2	31.6	32.0	0.4
Dec	26.6	27.1	0.5	30.5	30.8	0.2	31.4	31.9	0.5

BatteryIsland — Salinity (ppt) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	30.4	30.7	0.2	32.0	32.0	0.1	32.5	32.8	0.3
Feb	27.3	27.6	0.3	30.6	30.9	0.3	31.8	32.3	0.5
Mar	27.2	27.5	0.3	30.6	30.9	0.3	31.9	32.3	0.5
Apr	27.2	27.5	0.3	30.6	30.9	0.3	31.8	32.3	0.5
May	30.0	30.2	0.2	31.8	31.9	0.1	32.5	32.8	0.3
Jun	31.5	31.7	0.2	32.5	32.6	0.1	32.9	33.1	0.2
Jul	32.5	32.6	0.2	33.0	33.2	0.2	33.3	33.5	0.2
Aug	31.4	31.6	0.2	32.5	32.6	0.1	32.9	33.1	0.2
Sep	31.5	31.7	0.2	32.5	32.6	0.1	33.0	33.2	0.2
Oct	32.1	32.2	0.2	32.8	33.0	0.2	33.2	33.3	0.2
Nov	29.4	29.6	0.2	31.5	31.7	0.2	32.3	32.7	0.3
Dec	28.9	29.1	0.3	31.3	31.5	0.2	32.2	32.6	0.4

BaldheadShoalR1 — Salinity (ppt) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	32.6	32.6	0.0	33.6	33.6	0.0	33.8	33.9	0.1
Feb	30.5	30.5	0.0	33.0	33.0	0.0	33.4	33.6	0.2
Mar	30.5	30.5	0.0	33.0	33.0	0.0	33.5	33.6	0.2
Apr	30.5	30.5	0.0	33.0	33.0	0.0	33.4	33.6	0.2
May	32.2	32.3	0.0	33.6	33.5	0.0	33.8	33.9	0.1
Jun	33.1	33.1	0.0	33.9	33.9	0.0	34.0	34.1	0.1
Jul	33.7	33.7	0.1	34.2	34.2	0.0	34.3	34.3	0.0
Aug	33.1	33.1	0.0	33.9	33.9	0.0	34.0	34.1	0.0
Sep	33.1	33.1	0.0	33.9	33.9	0.0	34.0	34.1	0.1
Oct	33.4	33.5	0.0	34.1	34.0	0.0	34.2	34.2	0.0
Nov	31.8	31.9	0.0	33.4	33.4	0.0	33.7	33.8	0.1
Dec	31.6	31.6	0.0	33.3	33.3	0.0	33.6	33.7	0.1

BaldheadShoalR3 — Salinity (ppt) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	33.6	33.6	0.0	34.8	34.7	-0.1	35.0	35.0	0.0
Feb	32.6	32.6	0.0	34.9	34.9	0.0	35.0	35.0	0.0
Mar	32.6	32.6	0.0	34.9	34.9	0.0	35.0	35.0	0.0
Apr	32.6	32.6	0.1	34.9	34.9	0.0	35.0	35.0	0.0
May	33.4	33.4	0.0	34.9	34.8	-0.1	35.0	35.0	0.0
Jun	33.8	33.8	0.0	34.8	34.7	-0.1	35.0	34.9	-0.1
Jul	34.1	34.1	0.0	34.8	34.7	-0.1	35.0	34.9	-0.1
Aug	33.8	33.8	0.0	34.8	34.7	-0.1	35.0	34.9	-0.1
Sep	33.8	33.8	0.0	34.8	34.7	-0.1	35.0	34.9	-0.1
Oct	34.0	33.9	0.0	34.8	34.7	-0.1	35.0	34.9	-0.1
Nov	33.2	33.2	0.0	34.9	34.8	-0.1	35.0	35.0	0.0
Dec	33.1	33.1	0.0	34.9	34.8	-0.1	35.0	35.0	0.0

Appendix D–4:
Water Temperature

BL01 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.4	7.4	0.0	7.4	7.4	0.0	7.4	7.4	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.8	7.8	0.0	7.8	7.8	0.0	7.8	7.8	0.0
Feb	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.4	9.4	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.5	9.6	0.0
Mar	13.0	13.0	0.0	13.0	13.0	0.0	13.0	13.0	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.2	13.2	0.0	13.2	13.2	0.0	13.2	13.2	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0
Jun	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.9	25.9	0.0	25.9	25.9	0.0	25.8	25.9	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0
Jul	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0
Aug	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.4	27.4	0.0
Sep	24.9	24.9	0.0	24.9	24.9	0.0	24.9	24.9	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
Oct	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.8	19.8	0.0
Nov	14.8	14.8	0.0	14.8	14.8	0.0	14.8	14.8	0.0	14.8	14.8	0.0	14.8	14.8	0.0	14.8	14.8	0.0	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0
Dec	9.9	9.9	0.0	9.9	9.9	0.0	9.8	9.8	0.0	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.2	10.2	0.0

NECF04 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.2	8.2	0.0	8.2	8.2	0.0	8.2	8.2	0.0	8.4	8.4	0.0	8.4	8.4	0.0	8.4	8.4	0.0	8.8	8.8	0.0	8.8	8.8	0.0	8.8	8.8	0.0
Feb	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.7	9.7	0.0	9.7	9.7	0.0	9.7	9.7	0.0	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0
Mar	13.2	13.2	0.0	13.2	13.2	0.0	13.2	13.2	0.0	13.3	13.3	0.0	13.3	13.3	0.0	13.3	13.3	0.0	13.5	13.5	0.0	13.4	13.5	0.0	13.4	13.5	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.2	18.2	0.0	18.2	18.2	0.0	18.2	18.2	0.0
May	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.7	22.7	0.0	22.7	22.7	0.0	22.7	22.7	0.0
Jun	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.1	26.1	0.0	26.1	26.1	0.0	26.1	26.1	0.0	26.3	26.3	0.0	26.3	26.3	0.0	26.3	26.3	0.0
Jul	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.2	28.2	0.0	28.2	28.2	0.0	28.2	28.2	0.0
Aug	27.6	27.7	0.0	27.6	27.7	0.0	27.6	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Sep	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.6	25.6	0.0	25.6	25.6	0.0	25.6	25.6	0.0
Oct	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.7	20.7	0.0	20.7	20.7	0.0	20.7	20.7	0.0
Nov	15.5	15.5	0.0	15.5	15.5	0.0	15.5	15.5	0.0	15.6	15.6	0.0	15.6	15.6	0.0	15.6	15.6	0.0	15.9	15.9	0.0	15.9	15.9	0.0	15.9	15.9	0.0
Dec	10.7	10.7	0.0	10.7	10.7	0.0	10.7	10.7	0.0	10.8	10.8	0.0	10.8	10.8	0.0	10.8	10.8	0.0	11.2	11.2	0.0	11.2	11.2	0.0	11.2	11.2	0.0

CFR04 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	6.7	6.8	0.0	6.7	6.7	0.0	6.7	6.7	0.0	6.8	6.8	0.0	6.8	6.8	0.0	6.8	6.8	0.0	6.8	6.8	0.0	6.8	6.8	0.0	6.8	6.8	0.0
Feb	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.3	9.3	0.0	9.2	9.3	0.0	9.2	9.2	0.0
Mar	12.8	12.8	0.0	12.8	12.8	0.0	12.8	12.8	0.0	12.8	12.8	0.0	12.8	12.8	0.0	12.8	12.8	0.0	12.9	12.9	0.0	12.9	12.9	0.0	12.9	12.9	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.1	18.1	0.0	18.0	18.0	0.0	18.0	18.0	0.0
May	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0
Jun	25.9	25.9	0.0	25.9	25.9	0.0	25.9	25.9	0.0	25.9	25.9	0.0	25.9	25.9	0.0	25.9	25.9	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0
Jul	28.1	28.1	0.0	28.1	28.1	0.0	28.1	28.1	0.0	28.1	28.1	0.0	28.1	28.1	0.0	28.1	28.1	0.0	28.2	28.2	0.0	28.2	28.2	0.0	28.2	28.2	0.0
Aug	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Sep	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0
Oct	20.0	20.0	0.0	20.0	20.0	0.0	20.0	20.0	0.0	20.1	20.1	0.0	20.1	20.1	0.0	20.1	20.1	0.0	20.2	20.2	0.0	20.2	20.2	0.0	20.2	20.2	0.0
Nov	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0
Dec	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.6	0.0

NECF03 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.9	9.0	0.0	8.9	9.0	0.0	8.9	9.0	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.4	9.5	0.0	9.4	9.5	0.0	9.4	9.4	0.0
Feb	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.2	10.2	0.0
Mar	13.4	13.4	0.0	13.4	13.4	0.0	13.4	13.4	0.0	13.5	13.5	0.0	13.5	13.5	0.0	13.5	13.5	0.0	13.7	13.7	0.0	13.7	13.7	0.0	13.7	13.7	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.3	18.3	0.0	18.3	18.3	0.0	18.2	18.3	0.0
May	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0
Jun	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.2	26.2	0.0	26.1	26.1	0.0	26.1	26.1	0.0
Jul	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Aug	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.7	0.0	27.6	27.7	0.0	27.6	27.6	0.0
Sep	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.3	25.3	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0
Oct	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.5	0.0	20.5	20.5	0.0	20.4	20.5	0.0
Nov	15.6	15.6	0.0	15.6	15.6	0.0	15.6	15.6	0.0	15.6	15.6	0.0	15.6	15.6	0.0	15.6	15.6	0.0	15.7	15.7	0.0	15.7	15.7	0.0	15.7	15.7	0.0
Dec	11.1	11.1	0.0	11.1	11.1	0.0	11.1	11.1	0.0	11.2	11.2	0.0	11.2	11.2	0.0	11.2	11.2	0.0	11.5	11.5	0.0	11.5	11.5	0.0	11.5	11.5	0.0

CFR03 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.6	7.6	0.0	7.4	7.4	0.0	7.4	7.4	0.0	7.6	7.6	0.0	7.4	7.4	0.0	7.4	7.4	0.0	7.9	7.9	0.0	7.7	7.7	0.0	7.7	7.7	0.0
Feb	9.5	9.5	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.5	9.5	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.6	9.6	0.0	9.5	9.5	0.0	9.5	9.5	0.0
Mar	13.1	13.1	0.0	13.0	13.0	0.0	13.0	13.0	0.0	13.1	13.1	0.0	13.0	13.0	0.0	13.0	13.0	0.0	13.2	13.2	0.0	13.1	13.1	0.0	13.1	13.1	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	22.3	22.3	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.5	22.5	0.0	22.5	22.5	0.0	22.5	22.5	0.0
Jun	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0
Jul	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.4	27.4	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.5	27.4	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0
Sep	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	24.9	24.9	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.1	25.1	0.0	25.1	25.1	0.0
Oct	19.8	19.8	0.0	19.8	19.8	0.0	19.9	19.8	0.0	19.7	19.7	0.0	19.8	19.8	0.0	19.8	19.8	0.0	19.9	19.9	0.0	19.9	19.9	0.0	19.9	19.9	0.0
Nov	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0	14.8	14.8	0.0	14.9	14.9	0.0	14.9	14.9	0.0	15.1	15.1	0.0	15.1	15.1	0.0	15.1	15.1	0.0
Dec	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.0	10.0	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.2	10.2	0.0	10.1	10.2	0.0	10.1	10.2	0.0

NECF02 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.6	0.0
Feb	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.0	10.0	0.0	10.0	10.0	0.0	10.0	10.0	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.2	10.2	0.0
Mar	13.4	13.4	0.0	13.4	13.4	0.0	13.4	13.4	0.0	13.5	13.5	0.0	13.5	13.5	0.0	13.5	13.5	0.0	13.7	13.7	0.0	13.7	13.7	0.0	13.7	13.7	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.2	18.2	0.0	18.2	18.2	0.0	18.2	18.2	0.0
May	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0
Jun	26.0	25.9	0.0	25.9	25.9	0.0	25.9	25.9	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0	26.1	26.1	0.0	26.1	26.1	0.0	26.1	26.1	0.0
Jul	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Aug	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0
Sep	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0
Oct	20.5	20.5	0.0	20.5	20.5	0.0	20.5	20.5	0.0	20.5	20.5	0.0	20.5	20.5	0.0	20.5	20.5	0.0	20.6	20.6	0.0	20.6	20.6	0.0	20.6	20.6	0.0
Nov	15.7	15.7	0.0	15.7	15.7	0.0	15.7	15.7	0.0	15.7	15.7	0.0	15.7	15.7	0.0	15.7	15.7	0.0	15.9	15.9	0.0	15.9	15.9	0.0	15.9	15.9	0.0
Dec	11.3	11.3	0.0	11.3	11.3	0.0	11.3	11.3	0.0	11.3	11.4	0.0	11.3	11.4	0.0	11.3	11.4	0.0	11.6	11.6	0.0	11.6	11.6	0.0	11.6	11.6	0.0

CFR02 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.5	7.6	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.7	7.7	0.0	7.6	7.7	0.0	7.6	7.6	0.0	8.0	8.1	0.0	8.0	8.1	0.0	8.0	8.0	0.0
Feb	9.4	9.5	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.6	0.0
Mar	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.2	13.3	0.0	13.2	13.2	0.0	13.2	13.2	0.0
Apr	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0	22.4	22.4	0.0
Jun	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	26.0	26.0	0.0	25.9	26.0	0.0	25.9	26.0	0.0
Jul	27.9	27.8	0.0	27.9	27.8	0.0	27.9	27.9	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.9	0.0
Aug	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.4	27.5	0.0	27.4	27.5	0.0	27.4	27.5	0.0
Sep	25.1	25.1	0.0	25.1	25.1	0.0	25.1	25.1	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.1	0.0	25.1	25.1	0.0	25.1	25.1	0.0
Oct	19.9	19.9	0.0	19.9	19.9	0.0	19.9	19.9	0.0	19.9	19.9	0.0	19.9	19.9	0.0	19.9	19.9	0.0	20.0	20.0	0.0	20.0	20.0	0.0	20.0	20.0	0.0
Nov	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0	15.1	15.1	0.0	15.1	15.1	0.0	15.1	15.1	0.0
Dec	10.0	10.0	0.0	9.9	10.0	0.0	9.9	10.0	0.0	10.0	10.0	0.0	10.0	10.0	0.0	10.0	10.0	0.0	10.4	10.4	0.0	10.4	10.4	0.0	10.4	10.4	0.0

CFR01 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.7	7.8	0.0	7.8	7.8	0.1	7.8	7.8	0.1	7.9	7.9	0.0	7.9	8.0	0.1	7.9	8.0	0.1	8.3	8.4	0.0	8.4	8.5	0.1	8.5	8.5	0.1
Feb	9.5	9.5	0.0	9.5	9.5	0.0	9.4	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.7	9.7	0.0	9.7	9.7	0.0	9.7	9.7	0.0
Mar	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.3	13.3	0.0	13.3	13.3	0.0	13.3	13.3	0.0
Apr	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	17.9	18.0	0.0	17.9	17.9	0.0	17.9	17.9	0.0	18.1	18.1	0.0	18.0	18.0	0.0	18.0	18.0	0.0
May	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.4	22.4	0.0	22.4	22.3	0.0	22.4	22.3	0.0
Jun	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.7	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.9	25.9	0.0	25.9	25.9	0.0	25.9	25.9	0.0
Jul	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.6	27.6	0.0	27.6	27.6	0.0
Sep	25.2	25.1	0.0	25.2	25.2	0.0	25.2	25.2	0.0	25.1	25.1	0.0	25.2	25.2	0.0	25.2	25.2	0.0	25.2	25.2	0.0	25.3	25.4	0.0	25.3	25.4	0.0
Oct	20.1	20.1	0.0	20.2	20.2	0.0	20.2	20.2	0.0	20.1	20.1	0.0	20.2	20.2	0.0	20.2	20.3	0.1	20.3	20.3	0.0	20.4	20.5	0.1	20.4	20.5	0.1
Nov	15.1	15.1	0.0	15.3	15.3	0.1	15.3	15.3	0.1	15.2	15.2	0.0	15.3	15.4	0.1	15.3	15.4	0.1	15.5	15.5	0.0	15.6	15.7	0.1	15.7	15.7	0.1
Dec	10.1	10.2	0.0	10.2	10.3	0.1	10.2	10.3	0.1	10.2	10.3	0.0	10.3	10.4	0.1	10.4	10.4	0.1	10.7	10.7	0.0	10.9	10.9	0.1	10.9	11.0	0.1

NECF01 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.0	9.1	0.1	9.0	9.1	0.1	9.0	9.1	0.1	9.2	9.2	0.1	9.2	9.2	0.1	9.2	9.2	0.1	9.6	9.6	0.1	9.6	9.6	0.1	9.6	9.6	0.1
Feb	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.2	10.2	0.0
Mar	13.4	13.4	0.0	13.3	13.3	0.0	13.3	13.3	0.0	13.4	13.4	0.0	13.4	13.4	0.0	13.4	13.4	0.0	13.6	13.6	0.0	13.6	13.6	0.0	13.6	13.6	0.0
Apr	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	22.2	22.2	0.0	22.2	22.1	0.0	22.2	22.1	0.0	22.2	22.2	0.0	22.2	22.2	0.0	22.2	22.2	0.0	22.3	22.3	0.0	22.3	22.3	0.0	22.3	22.3	0.0
Jun	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.7	0.0	25.8	25.8	0.0	25.8	25.8	0.0	25.8	25.8	0.0	26.0	26.0	0.0	26.0	25.9	0.0	26.0	25.9	0.0
Jul	27.9	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.9	27.9	0.0	27.9	27.8	0.0	27.9	27.8	0.0	28.0	28.0	0.0	28.0	27.9	0.0	27.9	27.9	0.0
Aug	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.8	0.0	27.8	27.8	0.0
Sep	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0	25.6	25.6	0.0	25.6	25.7	0.0	25.6	25.7	0.0
Oct	20.7	20.7	0.0	20.7	20.8	0.1	20.7	20.8	0.1	20.7	20.7	0.1	20.7	20.8	0.1	20.7	20.8	0.1	20.9	20.9	0.1	20.9	21.0	0.1	20.9	21.0	0.1
Nov	15.9	15.9	0.1	15.9	16.0	0.1	15.9	16.0	0.1	15.9	16.0	0.1	15.9	16.0	0.1	15.9	16.0	0.1	16.2	16.2	0.1	16.2	16.3	0.1	16.2	16.3	0.1
Dec	11.3	11.4	0.1	11.3	11.4	0.1	11.3	11.4	0.1	11.4	11.5	0.1	11.4	11.5	0.1	11.4	11.5	0.1	11.8	11.8	0.1	11.8	11.9	0.1	11.8	11.9	0.1

Battleship — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.5	8.6	0.0	8.8	9.0	0.2	8.9	9.2	0.2	8.7	8.7	0.1	9.0	9.2	0.2	9.1	9.3	0.2	9.2	9.3	0.1	9.5	9.7	0.2	9.7	9.8	0.2
Feb	9.6	9.7	0.0	9.7	9.8	0.1	9.7	9.8	0.1	9.7	9.7	0.0	9.8	9.9	0.1	9.8	9.9	0.1	10.0	10.0	0.0	10.1	10.2	0.1	10.2	10.3	0.1
Mar	13.2	13.2	0.0	13.2	13.2	0.0	13.2	13.2	0.0	13.2	13.2	0.0	13.3	13.3	0.0	13.3	13.3	0.0	13.5	13.5	0.0	13.5	13.5	0.0	13.5	13.6	0.0
Apr	17.8	17.8	0.0	17.8	17.8	0.0	17.7	17.7	0.0	17.9	17.9	0.0	17.8	17.8	0.0	17.8	17.8	0.0	18.0	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0
May	22.2	22.2	0.0	22.1	22.1	-0.1	22.1	22.0	-0.1	22.2	22.2	0.0	22.1	22.1	-0.1	22.1	22.0	-0.1	22.3	22.3	0.0	22.2	22.2	0.0	22.2	22.2	0.0
Jun	25.7	25.7	0.0	25.7	25.6	-0.1	25.6	25.6	-0.1	25.8	25.7	0.0	25.7	25.7	0.0	25.7	25.6	-0.1	25.9	25.9	0.0	25.9	25.9	0.0	25.9	25.8	0.0
Jul	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.6	27.6	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.6	27.6	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.8	27.8	0.0	27.8	27.8	0.0
Sep	25.4	25.5	0.0	25.6	25.6	0.0	25.7	25.7	0.1	25.4	25.5	0.0	25.6	25.7	0.0	25.7	25.7	0.1	25.6	25.6	0.0	25.7	25.8	0.0	25.8	25.8	0.0
Oct	20.6	20.6	0.0	20.9	21.0	0.1	21.0	21.1	0.1	20.6	20.7	0.0	20.9	21.0	0.1	21.0	21.1	0.1	20.8	20.9	0.1	21.1	21.2	0.1	21.2	21.3	0.1
Nov	15.8	15.8	0.1	16.1	16.2	0.1	16.2	16.4	0.1	15.8	15.9	0.1	16.2	16.3	0.1	16.3	16.4	0.1	16.1	16.2	0.1	16.5	16.6	0.1	16.6	16.7	0.1
Dec	11.0	11.0	0.1	11.4	11.5	0.2	11.5	11.8	0.2	11.1	11.1	0.1	11.5	11.7	0.2	11.7	11.9	0.2	11.6	11.6	0.1	12.0	12.1	0.1	12.1	12.3	0.2

LowerAnchorageBasin — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.7	8.8	0.1	9.0	9.2	0.3	9.3	9.7	0.4	8.8	8.9	0.1	9.2	9.4	0.2	9.5	9.8	0.3	9.4	9.4	0.1	9.7	9.9	0.2	10.1	10.4	0.3
Feb	9.7	9.7	0.0	9.7	9.8	0.1	9.8	10.0	0.2	9.8	9.8	0.0	9.8	9.9	0.1	10.0	10.2	0.2	10.1	10.1	0.0	10.2	10.3	0.1	10.4	10.6	0.2
Mar	13.2	13.2	0.0	13.2	13.2	0.0	13.2	13.3	0.0	13.3	13.3	0.0	13.3	13.3	0.0	13.3	13.3	0.1	13.5	13.5	0.0	13.5	13.6	0.0	13.6	13.7	0.1
Apr	17.8	17.8	0.0	17.7	17.7	-0.1	17.7	17.6	-0.1	17.9	17.9	0.0	17.8	17.7	0.0	17.7	17.7	-0.1	18.1	18.0	0.0	18.0	18.0	0.0	18.0	17.9	0.0
May	22.2	22.1	0.0	22.0	22.0	-0.1	22.0	21.9	-0.1	22.2	22.2	0.0	22.1	22.0	-0.1	22.0	21.9	-0.1	22.3	22.3	0.0	22.2	22.1	-0.1	22.1	22.1	-0.1
Jun	25.7	25.7	0.0	25.6	25.5	-0.1	25.5	25.5	-0.1	25.8	25.7	0.0	25.6	25.6	-0.1	25.6	25.5	-0.1	25.9	25.9	0.0	25.9	25.8	0.0	25.8	25.8	-0.1
Jul	27.8	27.8	0.0	27.8	27.7	0.0	27.7	27.7	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.7	0.0	28.0	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.7	27.6	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.9	27.9	0.0
Sep	25.5	25.5	0.0	25.7	25.7	0.1	25.7	25.8	0.1	25.5	25.5	0.0	25.7	25.7	0.1	25.8	25.8	0.1	25.6	25.7	0.0	25.8	25.9	0.1	25.9	26.0	0.1
Oct	20.7	20.8	0.1	21.1	21.2	0.1	21.2	21.4	0.2	20.7	20.8	0.1	21.1	21.2	0.1	21.3	21.4	0.2	21.0	21.0	0.1	21.3	21.4	0.1	21.5	21.6	0.1
Nov	15.9	16.0	0.1	16.3	16.5	0.2	16.6	16.8	0.2	16.0	16.1	0.1	16.4	16.6	0.2	16.7	16.9	0.2	16.3	16.4	0.1	16.7	16.8	0.1	17.0	17.1	0.2
Dec	11.1	11.2	0.1	11.6	11.8	0.2	12.0	12.3	0.3	11.3	11.4	0.1	11.7	12.0	0.2	12.1	12.4	0.3	11.7	11.8	0.1	12.2	12.4	0.2	12.6	12.9	0.2

LowerBigIsland — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.3	9.3	0.1	9.7	10.0	0.3	10.0	10.3	0.3	9.4	9.5	0.1	9.9	10.1	0.2	10.2	10.5	0.3	10.0	10.1	0.1	10.5	10.7	0.2	10.7	11.0	0.3
Feb	9.9	9.9	0.0	10.1	10.3	0.2	10.3	10.5	0.2	10.0	10.0	0.0	10.2	10.4	0.1	10.4	10.6	0.2	10.4	10.5	0.0	10.7	10.8	0.1	10.8	11.0	0.2
Mar	13.3	13.3	0.0	13.3	13.4	0.1	13.4	13.5	0.1	13.4	13.4	0.0	13.4	13.5	0.0	13.5	13.6	0.1	13.7	13.7	0.0	13.7	13.8	0.0	13.8	13.9	0.1
Apr	17.8	17.8	0.0	17.7	17.7	0.0	17.7	17.7	0.0	17.9	17.8	0.0	17.8	17.8	0.0	17.8	17.7	0.0	18.1	18.0	0.0	18.0	18.0	0.0	18.0	18.0	0.0
May	22.1	22.0	0.0	21.9	21.9	-0.1	21.9	21.8	-0.1	22.1	22.1	0.0	22.0	21.9	-0.1	21.9	21.9	-0.1	22.2	22.2	0.0	22.1	22.1	0.0	22.1	22.0	-0.1
Jun	25.6	25.6	0.0	25.5	25.4	-0.1	25.5	25.4	-0.1	25.7	25.7	0.0	25.6	25.5	-0.1	25.5	25.5	-0.1	25.9	25.9	0.0	25.8	25.8	0.0	25.8	25.8	-0.1
Jul	27.8	27.7	0.0	27.7	27.7	0.0	27.7	27.6	0.0	27.8	27.8	0.0	27.7	27.7	0.0	27.7	27.7	0.0	28.0	28.0	0.0	28.0	27.9	0.0	27.9	27.9	0.0
Aug	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.8	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Sep	25.7	25.7	0.0	25.8	25.9	0.1	25.8	25.9	0.1	25.7	25.7	0.0	25.8	25.9	0.1	25.9	26.0	0.1	25.9	25.9	0.0	26.0	26.1	0.0	26.1	26.1	0.1
Oct	21.1	21.2	0.1	21.4	21.5	0.1	21.5	21.7	0.2	21.2	21.2	0.1	21.5	21.6	0.1	21.6	21.7	0.2	21.4	21.5	0.1	21.7	21.8	0.1	21.8	21.9	0.1
Nov	16.5	16.6	0.1	16.9	17.1	0.2	17.0	17.2	0.2	16.6	16.6	0.1	17.0	17.1	0.1	17.1	17.3	0.2	16.9	17.0	0.1	17.3	17.4	0.1	17.4	17.5	0.2
Dec	11.8	11.9	0.1	12.4	12.6	0.2	12.6	12.9	0.3	11.9	12.0	0.1	12.5	12.7	0.2	12.7	13.0	0.3	12.5	12.6	0.1	13.0	13.1	0.2	13.2	13.4	0.2

LowerLilliput — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.0	10.1	0.1	10.9	11.1	0.3	11.1	11.4	0.3	10.2	10.3	0.1	11.0	11.3	0.2	11.3	11.6	0.3	10.7	10.9	0.1	11.5	11.7	0.2	11.7	12.0	0.3
Feb	10.3	10.4	0.1	10.9	11.0	0.2	11.1	11.3	0.2	10.4	10.5	0.1	11.0	11.2	0.2	11.2	11.4	0.2	10.9	10.9	0.1	11.4	11.6	0.2	11.6	11.8	0.2
Mar	13.5	13.5	0.0	13.7	13.7	0.1	13.8	13.8	0.1	13.6	13.6	0.0	13.8	13.8	0.1	13.8	13.9	0.1	13.9	13.9	0.0	14.1	14.1	0.1	14.1	14.2	0.1
Apr	17.8	17.8	0.0	17.8	17.7	0.0	17.7	17.7	0.0	17.9	17.9	0.0	17.8	17.8	0.0	17.8	17.8	0.0	18.1	18.1	0.0	18.0	18.0	0.0	18.0	18.0	0.0
May	22.0	21.9	0.0	21.8	21.7	-0.1	21.8	21.7	-0.1	22.0	22.0	0.0	21.8	21.8	-0.1	21.8	21.8	-0.1	22.2	22.1	0.0	22.0	22.0	0.0	22.0	22.0	-0.1
Jun	25.5	25.5	0.0	25.4	25.3	0.0	25.3	25.3	-0.1	25.6	25.6	0.0	25.4	25.4	0.0	25.4	25.3	-0.1	25.9	25.8	0.0	25.8	25.7	0.0	25.8	25.7	-0.1
Jul	27.7	27.7	0.0	27.6	27.6	0.0	27.6	27.5	0.0	27.7	27.7	0.0	27.6	27.6	0.0	27.6	27.6	0.0	28.0	28.0	0.0	28.0	27.9	0.0	28.0	27.9	0.0
Aug	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.7	0.0	27.7	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	28.0	27.9	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Sep	25.8	25.8	0.0	26.0	26.0	0.1	26.0	26.1	0.1	25.9	25.9	0.0	26.0	26.1	0.1	26.1	26.1	0.1	26.1	26.1	0.0	26.3	26.3	0.0	26.3	26.3	0.1
Oct	21.5	21.5	0.1	21.9	22.0	0.1	22.0	22.1	0.1	21.5	21.6	0.1	22.0	22.1	0.1	22.0	22.2	0.1	21.8	21.8	0.1	22.2	22.3	0.1	22.3	22.4	0.1
Nov	17.0	17.1	0.1	17.6	17.7	0.2	17.7	17.9	0.2	17.1	17.2	0.1	17.7	17.8	0.1	17.7	17.9	0.2	17.4	17.5	0.1	17.9	18.0	0.1	18.0	18.2	0.2
Dec	12.6	12.7	0.1	13.4	13.6	0.2	13.6	13.9	0.3	12.7	12.8	0.1	13.5	13.7	0.2	13.7	13.9	0.2	13.2	13.3	0.1	13.9	14.1	0.2	14.1	14.3	0.2

LowerMidnight — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.0	11.2	0.1	12.1	12.2	0.2	12.4	12.6	0.2	11.2	11.3	0.1	12.2	12.3	0.2	12.5	12.7	0.2	11.7	11.9	0.2	12.6	12.7	0.2	12.8	13.0	0.2
Feb	11.0	11.1	0.1	11.7	11.8	0.1	12.0	12.1	0.2	11.1	11.2	0.1	11.8	11.9	0.1	12.1	12.2	0.1	11.6	11.7	0.1	12.2	12.3	0.1	12.4	12.6	0.2
Mar	13.8	13.8	0.0	14.1	14.1	0.1	14.2	14.2	0.1	13.8	13.9	0.0	14.1	14.2	0.1	14.3	14.3	0.1	14.2	14.2	0.0	14.4	14.5	0.1	14.5	14.6	0.1
Apr	17.8	17.8	0.0	17.8	17.8	0.0	17.8	17.8	0.0	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	18.1	18.1	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	21.8	21.8	0.0	21.7	21.6	0.0	21.6	21.6	0.0	21.9	21.8	0.0	21.7	21.7	0.0	21.7	21.6	0.0	22.1	22.0	0.0	21.9	21.9	0.0	21.9	21.9	0.0
Jun	25.4	25.4	0.0	25.2	25.2	0.0	25.2	25.2	0.0	25.4	25.4	0.0	25.3	25.2	0.0	25.2	25.2	0.0	25.8	25.8	0.0	25.7	25.7	0.0	25.7	25.7	-0.1
Jul	27.6	27.6	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.6	27.6	0.0	27.6	27.6	0.0	27.5	27.5	0.0	28.0	28.0	0.0	28.0	27.9	0.0	28.0	27.9	0.0
Aug	27.7	27.7	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	28.1	28.1	0.0	28.1	28.1	0.0	28.1	28.1	0.0
Sep	26.0	26.0	0.0	26.2	26.2	0.0	26.2	26.3	0.0	26.1	26.1	0.0	26.3	26.3	0.0	26.3	26.3	0.0	26.3	26.4	0.0	26.5	26.5	0.0	26.5	26.6	0.0
Oct	22.0	22.0	0.1	22.4	22.5	0.1	22.5	22.6	0.1	22.1	22.1	0.1	22.5	22.5	0.1	22.6	22.7	0.1	22.3	22.4	0.1	22.7	22.8	0.1	22.8	22.9	0.1
Nov	17.7	17.8	0.1	18.3	18.4	0.1	18.4	18.6	0.1	17.8	17.9	0.1	18.4	18.5	0.1	18.5	18.6	0.1	18.1	18.2	0.1	18.6	18.7	0.1	18.7	18.8	0.1
Dec	13.5	13.6	0.1	14.4	14.6	0.1	14.7	14.9	0.2	13.6	13.7	0.1	14.5	14.6	0.1	14.7	14.9	0.2	14.1	14.3	0.2	14.9	15.0	0.1	15.1	15.2	0.2

SnowMarsh — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	12.4	12.5	0.1	13.3	13.4	0.1	13.6	13.7	0.2	12.4	12.6	0.1	13.4	13.5	0.1	13.6	13.8	0.2	12.8	12.9	0.2	13.6	13.8	0.2	13.8	14.0	0.2
Feb	11.9	12.0	0.1	12.6	12.7	0.1	12.8	13.0	0.2	12.0	12.1	0.1	12.7	12.8	0.1	12.9	13.0	0.1	12.4	12.5	0.1	13.1	13.2	0.1	13.2	13.4	0.1
Mar	14.2	14.2	0.0	14.5	14.5	0.0	14.6	14.6	0.1	14.3	14.3	0.0	14.5	14.6	0.0	14.6	14.7	0.1	14.6	14.6	0.0	14.8	14.9	0.0	14.9	15.0	0.1
Apr	17.9	17.9	0.0	17.8	17.8	0.0	17.8	17.8	0.0	17.9	17.9	0.0	17.9	17.9	0.0	17.9	17.9	0.0	18.2	18.2	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	21.7	21.6	0.0	21.5	21.5	0.0	21.5	21.5	0.0	21.7	21.7	0.0	21.6	21.6	0.0	21.5	21.5	0.0	22.0	21.9	0.0	21.8	21.8	0.0	21.8	21.8	0.0
Jun	25.2	25.2	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.3	25.2	0.0	25.1	25.1	0.0	25.0	25.0	0.0	25.8	25.7	0.0	25.7	25.6	0.0	25.7	25.6	0.0
Jul	27.5	27.5	0.0	27.4	27.4	0.0	27.4	27.4	0.0	27.5	27.5	0.0	27.5	27.5	0.0	27.4	27.4	0.0	28.0	28.0	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.1	28.1	0.0	28.2	28.2	0.0	28.2	28.2	0.0
Sep	26.2	26.3	0.0	26.4	26.4	0.0	26.5	26.5	0.0	26.3	26.3	0.0	26.5	26.5	0.0	26.5	26.6	0.0	26.5	26.6	0.0	26.7	26.7	0.0	26.8	26.8	0.0
Oct	22.5	22.6	0.1	22.9	23.0	0.0	23.0	23.1	0.1	22.6	22.7	0.1	23.0	23.1	0.0	23.1	23.2	0.1	22.8	22.8	0.1	23.2	23.2	0.0	23.3	23.3	0.1
Nov	18.5	18.6	0.1	19.1	19.1	0.1	19.2	19.3	0.1	18.6	18.6	0.1	19.1	19.2	0.0	19.2	19.3	0.1	18.7	18.8	0.1	19.3	19.3	0.1	19.4	19.5	0.1
Dec	14.7	14.8	0.1	15.5	15.6	0.1	15.7	15.9	0.2	14.7	14.8	0.1	15.5	15.6	0.1	15.7	15.9	0.1	15.0	15.2	0.1	15.8	15.9	0.1	16.0	16.1	0.1

BatteryIsland — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	13.0	13.1	0.1	13.9	13.9	0.1	14.1	14.2	0.1	13.1	13.2	0.1	13.9	14.0	0.1	14.1	14.2	0.1	13.4	13.5	0.1	14.1	14.2	0.1	14.3	14.4	0.2
Feb	12.4	12.5	0.1	13.1	13.1	0.0	13.3	13.4	0.1	12.5	12.6	0.0	13.1	13.2	0.0	13.3	13.4	0.1	12.9	12.9	0.1	13.4	13.5	0.1	13.6	13.7	0.1
Mar	14.4	14.4	0.0	14.7	14.7	0.0	14.8	14.8	0.1	14.5	14.5	0.0	14.7	14.8	0.0	14.8	14.9	0.0	14.8	14.8	0.0	15.0	15.0	0.0	15.1	15.1	0.0
Apr	17.9	17.9	0.0	17.9	17.9	0.0	17.8	17.9	0.0	17.9	18.0	0.0	17.9	17.9	0.0	17.9	17.9	0.0	18.2	18.2	0.0	18.1	18.2	0.0	18.1	18.1	0.0
May	21.6	21.6	0.0	21.4	21.4	0.0	21.4	21.4	0.0	21.6	21.6	0.0	21.5	21.5	0.0	21.5	21.5	0.0	21.9	21.8	0.0	21.8	21.7	0.0	21.7	21.7	0.0
Jun	25.1	25.1	0.0	24.9	25.0	0.0	24.9	24.9	0.0	25.1	25.1	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.7	25.7	0.0	25.7	25.6	0.0	25.6	25.6	0.0
Jul	27.4	27.4	0.0	27.3	27.3	0.0	27.3	27.3	0.0	27.5	27.5	0.0	27.4	27.4	0.0	27.4	27.4	0.0	28.0	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.8	27.8	0.0	27.8	27.8	0.0	27.8	27.8	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.2	28.2	0.0	28.2	28.2	0.0	28.2	28.2	0.0
Sep	26.4	26.4	0.0	26.5	26.6	0.0	26.6	26.6	0.0	26.5	26.5	0.0	26.6	26.6	0.0	26.7	26.7	0.0	26.7	26.7	0.0	26.8	26.8	0.0	26.9	26.9	0.0
Oct	22.8	22.9	0.1	23.2	23.2	0.0	23.3	23.4	0.1	22.9	23.0	0.1	23.3	23.3	0.0	23.4	23.4	0.0	23.1	23.2	0.0	23.4	23.4	0.0	23.5	23.5	0.0
Nov	18.9	19.0	0.1	19.4	19.5	0.1	19.5	19.6	0.1	19.0	19.1	0.1	19.4	19.5	0.0	19.6	19.6	0.0	19.2	19.3	0.1	19.6	19.6	0.0	19.7	19.7	0.0
Dec	15.3	15.4	0.1	16.0	16.1	0.1	16.2	16.3	0.1	15.3	15.4	0.1	16.0	16.1	0.1	16.2	16.3	0.1	15.6	15.7	0.1	16.2	16.3	0.1	16.4	16.5	0.1

BaldheadShoalR1 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	14.0	14.0	0.0	15.0	15.0	0.0	15.2	15.3	0.0	14.1	14.1	0.0	14.9	14.9	0.0	15.2	15.2	0.0	14.3	14.4	0.1	14.9	15.0	0.1	15.1	15.2	0.1
Feb	13.1	13.1	0.0	13.9	13.9	0.0	14.1	14.1	0.0	13.2	13.2	0.0	13.9	13.9	0.0	14.1	14.1	0.0	13.6	13.6	0.0	14.1	14.1	0.0	14.3	14.3	0.1
Mar	14.7	14.7	0.0	15.0	15.1	0.0	15.1	15.1	0.0	14.8	14.8	0.0	15.1	15.1	0.0	15.2	15.2	0.0	15.1	15.1	0.0	15.3	15.3	0.0	15.4	15.4	0.0
Apr	17.9	17.9	0.0	17.8	17.9	0.0	17.8	17.9	0.0	18.0	18.0	0.0	17.9	17.9	0.0	17.9	17.9	0.0	18.2	18.2	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	21.4	21.4	0.0	21.3	21.3	0.0	21.2	21.2	0.0	21.5	21.5	0.0	21.3	21.4	0.0	21.3	21.3	0.0	21.7	21.7	0.0	21.7	21.6	0.0	21.6	21.6	0.0
Jun	24.9	24.9	0.0	24.7	24.8	0.0	24.7	24.7	0.0	24.9	25.0	0.0	24.8	24.8	0.0	24.7	24.8	0.0	25.6	25.6	0.0	25.6	25.6	0.0	25.6	25.5	0.0
Jul	27.3	27.3	0.0	27.2	27.2	0.0	27.2	27.2	0.0	27.4	27.4	0.0	27.3	27.3	0.0	27.3	27.3	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0
Aug	27.8	27.8	0.0	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.2	28.2	0.0	28.3	28.3	0.0	28.3	28.3	0.0
Sep	26.6	26.6	0.0	26.8	26.8	0.0	26.8	26.8	0.0	26.7	26.7	0.0	26.9	26.9	0.0	26.9	26.9	0.0	26.9	26.9	0.0	27.0	27.0	0.0	27.1	27.1	0.0
Oct	23.4	23.4	0.0	23.8	23.8	0.0	23.9	23.9	0.0	23.5	23.5	0.0	23.8	23.8	0.0	23.9	23.9	0.0	23.7	23.6	0.0	23.9	23.9	0.0	23.9	23.9	0.0
Nov	19.7	19.7	0.0	20.2	20.2	0.0	20.3	20.3	0.0	19.7	19.7	0.0	20.2	20.1	0.0	20.3	20.2	0.0	19.9	19.9	0.0	20.2	20.2	0.0	20.3	20.2	0.0
Dec	16.2	16.3	0.0	17.0	17.0	0.0	17.3	17.3	0.0	16.2	16.2	0.0	16.9	16.9	0.0	17.2	17.2	0.0	16.5	16.5	0.0	17.0	17.0	0.0	17.2	17.2	0.0

BaldheadShoalR3 — Water Temperature (°C) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	15.3	15.3	0.0	16.7	16.7	-0.1	16.8	16.7	-0.1	15.3	15.3	0.1	16.6	16.5	0.0	16.6	16.6	0.0	15.3	15.5	0.1	16.3	16.4	0.2	16.4	16.5	0.2
Feb	14.1	14.1	0.1	15.1	15.1	0.0	15.1	15.1	0.0	14.1	14.2	0.0	15.0	15.0	0.0	15.1	15.1	0.0	14.4	14.4	0.1	15.1	15.1	0.0	15.1	15.2	0.0
Mar	15.1	15.2	0.0	15.5	15.5	0.0	15.5	15.5	0.0	15.2	15.2	0.0	15.5	15.5	0.0	15.5	15.5	0.0	15.4	15.5	0.0	15.7	15.7	0.0	15.7	15.7	0.0
Apr	17.9	17.9	0.0	17.8	17.8	0.0	17.7	17.8	0.0	17.9	18.0	0.0	17.8	17.8	0.0	17.8	17.8	0.0	18.1	18.2	0.0	18.0	18.0	0.1	17.9	18.0	0.1
May	21.2	21.2	0.0	20.8	20.8	0.1	20.7	20.8	0.1	21.2	21.3	0.0	20.8	20.9	0.0	20.8	20.8	0.0	21.6	21.5	0.0	21.3	21.3	0.0	21.2	21.2	0.0
Jun	24.6	24.6	0.0	24.2	24.2	0.0	24.1	24.1	0.0	24.6	24.7	0.0	24.2	24.3	0.1	24.1	24.2	0.1	25.6	25.5	0.0	25.5	25.4	0.0	25.4	25.4	0.0
Jul	27.1	27.2	0.0	26.9	26.9	0.0	26.8	26.8	0.0	27.2	27.3	0.0	27.0	27.0	0.1	26.9	27.0	0.1	27.9	27.9	0.0	27.8	27.8	0.0	27.8	27.8	0.0
Aug	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.9	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0	28.3	28.3	0.0	28.3	28.3	0.0	28.3	28.3	0.0
Sep	26.9	26.9	0.0	27.3	27.3	0.0	27.3	27.3	0.0	27.0	27.0	0.0	27.3	27.3	0.0	27.4	27.4	0.0	27.2	27.2	0.0	27.3	27.3	0.0	27.4	27.3	0.0
Oct	24.1	24.1	0.0	25.0	25.0	0.0	25.1	25.0	0.0	24.1	24.1	0.0	25.0	24.9	-0.1	25.1	25.0	0.0	24.2	24.2	0.0	24.6	24.6	0.0	24.7	24.6	0.0
Nov	20.5	20.6	0.0	21.7	21.7	0.0	21.8	21.8	0.0	20.5	20.5	0.0	21.6	21.5	-0.1	21.7	21.6	-0.1	20.6	20.6	0.0	21.1	21.1	0.0	21.2	21.1	0.0
Dec	17.4	17.4	0.1	18.9	18.8	0.0	18.9	18.9	0.0	17.3	17.3	0.0	18.6	18.6	-0.1	18.7	18.6	-0.1	17.5	17.5	0.0	18.4	18.5	0.0	18.5	18.5	0.0

BL01 — Water Temperature (°C) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.1	7.0	0.0	7.1	7.0	0.0	7.0	7.0	0.0
Feb	10.5	10.5	0.0	10.5	10.5	0.0	10.4	10.5	0.0
Mar	13.8	13.8	0.0	13.8	13.8	0.0	13.8	13.8	0.0
Apr	19.2	19.2	0.0	19.2	19.2	0.0	19.2	19.2	0.0
May	23.1	23.0	0.0	23.1	23.0	0.0	23.1	23.0	0.0
Jun	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Jul	29.0	29.0	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Aug	28.7	28.7	0.0	28.7	28.7	0.0	28.7	28.7	0.0
Sep	25.4	25.4	0.0	25.4	25.4	0.0	25.4	25.4	0.0
Oct	20.4	20.4	0.0	20.4	20.4	0.0	20.4	20.4	0.0
Nov	15.5	15.5	0.0	15.5	15.5	0.0	15.4	15.5	0.0
Dec	12.1	12.1	0.0	12.1	12.1	0.0	12.1	12.1	0.0

NECF04 — Water Temperature (°C) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.8	7.8	0.0	7.8	7.8	0.0	7.7	7.8	0.0
Feb	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0
Mar	14.7	14.7	0.0	14.7	14.7	0.0	14.7	14.7	0.0
Apr	19.1	19.1	0.0	19.1	19.1	0.0	19.1	19.1	0.0
May	23.2	23.2	0.0	23.2	23.2	0.0	23.2	23.2	0.0
Jun	28.3	28.3	0.0	28.3	28.3	0.0	28.3	28.3	0.0
Jul	29.0	29.0	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Aug	29.0	29.0	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Sep	25.6	25.6	0.0	25.6	25.6	0.0	25.6	25.6	0.0
Oct	20.9	20.9	0.0	20.9	20.9	0.0	20.9	20.9	0.0
Nov	16.3	16.3	0.0	16.3	16.3	0.0	16.3	16.3	0.0
Dec	13.3	13.3	0.0	13.3	13.3	0.0	13.3	13.3	0.0

CFR04 — Water Temperature (°C) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.2	7.2	0.0	7.2	7.2	0.0	7.2	7.2	0.0
Feb	10.0	10.0	0.0	9.9	9.9	0.0	9.9	9.9	0.0
Mar	13.4	13.4	0.0	13.4	13.4	0.0	13.4	13.4	0.0
Apr	18.9	18.9	0.0	18.8	18.9	0.0	18.8	18.8	0.0
May	23.3	23.3	0.0	23.3	23.3	0.0	23.3	23.3	0.0
Jun	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Jul	29.4	29.4	0.0	29.4	29.4	0.0	29.4	29.4	0.0
Aug	29.2	29.2	0.0	29.2	29.2	0.0	29.2	29.3	0.0
Sep	26.0	26.0	0.0	26.0	26.0	0.0	26.0	26.0	0.0
Oct	21.0	21.0	0.0	21.0	21.0	0.0	21.0	21.0	0.0
Nov	15.5	15.5	0.0	15.5	15.5	0.0	15.5	15.5	0.0
Dec	11.4	11.5	0.0	11.4	11.4	0.0	11.4	11.4	0.0

NECF03 — Water Temperature (°C) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.0	8.0	0.0	8.0	8.0	0.0	8.0	8.0	0.0
Feb	11.0	11.0	0.0	11.0	11.0	0.0	11.0	11.0	0.0
Mar	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0
Apr	19.1	19.1	0.0	19.1	19.1	0.0	19.1	19.1	0.0
May	23.1	23.1	0.0	23.1	23.1	0.0	23.1	23.1	0.0
Jun	28.2	28.2	0.0	28.2	28.2	0.0	28.2	28.2	0.0
Jul	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Aug	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Sep	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0
Oct	20.7	20.7	0.0	20.8	20.7	0.0	20.8	20.7	0.0
Nov	16.4	16.4	0.0	16.4	16.4	0.0	16.4	16.4	0.0
Dec	13.9	13.9	0.0	13.9	13.9	0.0	13.9	13.9	0.0

CFR03 — Water Temperature (°C) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.2	7.1	0.0	7.2	7.2	0.0	7.2	7.2	0.0
Feb	10.5	10.6	0.0	10.5	10.5	0.0	10.4	10.5	0.0
Mar	13.9	13.9	0.0	13.8	13.8	0.0	13.8	13.8	0.0
Apr	19.2	19.2	0.0	19.2	19.2	0.0	19.2	19.2	0.0
May	23.0	23.0	0.0	23.0	23.0	0.0	23.0	23.0	0.0
Jun	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Jul	28.9	28.9	0.0	29.0	28.9	0.0	29.0	28.9	0.0
Aug	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Sep	25.6	25.5	0.0	25.6	25.6	0.0	25.6	25.6	0.0
Oct	20.5	20.4	-0.1	20.6	20.5	-0.1	20.6	20.5	-0.1
Nov	15.7	15.7	0.0	15.6	15.6	0.0	15.6	15.6	0.0
Dec	12.3	12.3	0.0	12.2	12.3	0.0	12.2	12.2	0.0

NECF02 — Water Temperature (°C) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.4	8.4	0.0	8.4	8.4	0.0	8.4	8.4	0.0
Feb	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0
Mar	15.0	15.0	0.0	15.0	15.0	0.0	15.0	15.0	0.0
Apr	19.0	19.0	0.0	19.0	19.0	0.0	19.0	19.0	0.0
May	23.0	23.0	0.0	23.0	23.0	0.0	23.0	23.0	0.0
Jun	28.1	28.1	0.0	28.1	28.1	0.0	28.1	28.1	0.0
Jul	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Aug	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Sep	25.6	25.6	0.0	25.6	25.6	0.0	25.6	25.6	0.0
Oct	21.0	21.0	0.0	21.0	21.0	0.0	21.0	21.0	0.0
Nov	16.5	16.5	0.0	16.5	16.5	0.0	16.5	16.5	0.0
Dec	14.1	14.1	0.0	14.1	14.1	0.0	14.1	14.1	0.0

CFR02 — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.3	7.2	0.0	7.3	7.2	0.0	7.3	7.2	0.0
Feb	10.5	10.5	0.0	10.4	10.4	0.0	10.4	10.4	0.0
Mar	13.9	13.9	0.0	13.9	13.9	0.0	13.9	13.9	0.0
Apr	19.1	19.1	0.0	19.1	19.1	0.0	19.1	19.1	0.0
May	22.9	22.9	0.0	22.9	22.9	0.0	22.9	22.9	0.0
Jun	28.0	28.0	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Jul	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Aug	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Sep	25.5	25.5	0.0	25.5	25.5	0.0	25.5	25.5	0.0
Oct	20.5	20.5	0.0	20.5	20.5	0.0	20.5	20.5	0.0
Nov	15.7	15.7	0.0	15.7	15.7	0.0	15.7	15.7	0.0
Dec	12.4	12.4	0.0	12.4	12.4	0.0	12.4	12.4	0.0

CFR01 — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.9	7.9	0.0	8.2	8.2	0.1	8.2	8.3	0.1
Feb	10.5	10.5	0.0	10.5	10.6	0.0	10.5	10.6	0.0
Mar	14.1	14.1	0.0	14.2	14.2	0.0	14.2	14.2	0.0
Apr	19.0	19.0	0.0	18.9	18.9	0.0	18.9	18.9	0.0
May	22.8	22.8	0.0	22.7	22.7	0.0	22.7	22.7	0.0
Jun	27.9	27.9	0.0	27.9	27.9	0.0	27.9	27.8	0.0
Jul	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Aug	28.8	28.8	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Sep	25.6	25.6	0.0	25.6	25.6	0.0	25.6	25.6	0.0
Oct	20.9	20.9	0.0	21.0	21.0	0.0	21.1	21.1	0.0
Nov	16.0	16.0	0.0	16.1	16.1	0.0	16.1	16.2	0.1
Dec	12.8	12.9	0.1	13.0	13.1	0.1	13.1	13.1	0.1

NECF01 — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.9	9.0	0.1	9.0	9.1	0.1	9.0	9.1	0.1
Feb	10.8	10.8	0.0	10.8	10.8	0.0	10.7	10.8	0.0
Mar	14.9	14.9	0.0	14.9	14.9	0.0	14.9	14.9	0.0
Apr	18.7	18.7	0.0	18.7	18.7	0.0	18.7	18.6	0.0
May	22.9	22.8	0.0	22.8	22.8	0.0	22.8	22.8	-0.1
Jun	27.9	27.9	-0.1	27.9	27.8	-0.1	27.9	27.8	-0.1
Jul	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Aug	29.0	29.0	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Sep	25.7	25.7	0.0	25.8	25.8	0.0	25.8	25.8	0.0
Oct	21.3	21.3	0.0	21.3	21.4	0.0	21.4	21.4	0.0
Nov	16.7	16.7	0.0	16.7	16.8	0.1	16.7	16.8	0.1
Dec	14.2	14.2	0.1	14.2	14.3	0.1	14.2	14.3	0.1

Battleship — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.0	9.1	0.1	9.4	9.6	0.1	9.6	9.8	0.2
Feb	10.7	10.7	0.0	10.8	10.8	0.0	10.8	10.8	0.0
Mar	14.6	14.6	0.0	14.8	14.8	0.0	14.8	14.8	0.0
Apr	18.7	18.7	0.0	18.5	18.5	-0.1	18.4	18.4	-0.1
May	22.7	22.7	-0.1	22.7	22.6	-0.1	22.6	22.6	-0.1
Jun	27.8	27.8	-0.1	27.7	27.6	-0.1	27.7	27.6	-0.1
Jul	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.7	0.0
Aug	29.0	29.0	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Sep	25.8	25.8	0.0	25.9	25.9	0.0	25.9	25.9	0.0
Oct	21.4	21.4	0.0	21.6	21.6	0.1	21.7	21.7	0.1
Nov	16.6	16.7	0.0	16.9	17.0	0.1	17.0	17.1	0.1
Dec	13.9	14.0	0.1	14.3	14.4	0.1	14.4	14.6	0.1

LowerAnchorageBasin — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.2	9.3	0.1	9.8	9.9	0.2	10.1	10.3	0.2
Feb	10.8	10.8	0.0	10.9	10.9	0.0	11.0	11.1	0.1
Mar	14.7	14.7	0.0	14.8	14.8	0.0	14.9	14.9	0.0
Apr	18.7	18.6	0.0	18.4	18.3	-0.1	18.3	18.2	-0.1
May	22.7	22.7	-0.1	22.6	22.5	-0.1	22.6	22.5	-0.1
Jun	27.8	27.7	-0.1	27.6	27.5	-0.1	27.5	27.4	-0.1
Jul	28.8	28.8	0.0	28.7	28.7	0.0	28.7	28.7	0.0
Aug	29.0	29.0	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Sep	25.8	25.8	0.0	25.9	26.0	0.0	26.0	26.0	0.0
Oct	21.4	21.5	0.0	21.7	21.8	0.1	21.8	21.9	0.1
Nov	16.8	16.8	0.1	17.1	17.2	0.1	17.3	17.4	0.1
Dec	14.1	14.2	0.1	14.6	14.7	0.1	14.8	15.0	0.2

LowerBigIsland — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.0	10.1	0.1	10.5	10.6	0.2	10.6	10.8	0.2
Feb	11.2	11.2	0.0	11.3	11.4	0.0	11.4	11.4	0.1
Mar	14.9	14.9	0.0	14.9	14.9	0.0	15.0	15.0	0.0
Apr	18.6	18.6	0.0	18.4	18.3	-0.1	18.4	18.3	-0.1
May	22.6	22.6	-0.1	22.5	22.4	-0.1	22.5	22.4	-0.1
Jun	27.6	27.5	-0.1	27.4	27.4	-0.1	27.4	27.3	-0.1
Jul	28.7	28.7	0.0	28.7	28.6	0.0	28.6	28.6	0.0
Aug	29.0	28.9	0.0	29.0	29.0	0.0	29.0	29.0	0.0
Sep	25.9	26.0	0.0	26.0	26.1	0.0	26.0	26.1	0.1
Oct	21.7	21.8	0.1	21.9	22.0	0.1	22.0	22.1	0.1
Nov	17.3	17.4	0.1	17.5	17.7	0.1	17.6	17.7	0.1
Dec	14.8	14.9	0.1	15.2	15.4	0.1	15.3	15.5	0.2

LowerLilliput — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.7	10.8	0.1	11.3	11.4	0.2	11.4	11.6	0.2
Feb	11.6	11.6	0.0	11.8	11.9	0.0	11.9	11.9	0.1
Mar	15.0	15.0	0.0	15.1	15.1	0.0	15.1	15.1	0.0
Apr	18.5	18.5	0.0	18.4	18.3	-0.1	18.3	18.3	-0.1
May	22.5	22.4	-0.1	22.3	22.3	-0.1	22.3	22.2	-0.1
Jun	27.4	27.3	-0.1	27.2	27.1	-0.1	27.2	27.1	-0.1
Jul	28.6	28.6	0.0	28.5	28.5	0.0	28.5	28.5	0.0
Aug	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Sep	26.1	26.1	0.0	26.2	26.2	0.0	26.2	26.3	0.1
Oct	22.0	22.1	0.1	22.2	22.3	0.1	22.3	22.4	0.1
Nov	17.7	17.8	0.1	18.1	18.2	0.1	18.1	18.3	0.1
Dec	15.4	15.5	0.1	16.0	16.1	0.1	16.0	16.2	0.2

LowerMidnight — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.6	11.7	0.1	12.2	12.3	0.1	12.3	12.4	0.2
Feb	12.0	12.0	0.0	12.3	12.3	0.0	12.4	12.4	0.0
Mar	15.1	15.1	0.0	15.1	15.1	0.0	15.2	15.2	0.0
Apr	18.4	18.4	0.0	18.3	18.2	0.0	18.2	18.2	0.0
May	22.3	22.2	-0.1	22.1	22.1	-0.1	22.1	22.0	-0.1
Jun	27.1	27.0	-0.1	26.9	26.8	-0.1	26.8	26.8	-0.1
Jul	28.5	28.5	0.0	28.4	28.4	0.0	28.4	28.4	0.0
Aug	28.9	28.9	0.0	28.9	28.9	0.0	28.9	28.9	0.0
Sep	26.3	26.3	0.0	26.4	26.4	0.0	26.4	26.5	0.0
Oct	22.4	22.4	0.1	22.6	22.7	0.1	22.7	22.8	0.1
Nov	18.3	18.4	0.1	18.7	18.8	0.1	18.8	18.9	0.1
Dec	16.2	16.3	0.1	16.7	16.8	0.1	16.8	16.9	0.1

SnowMarsh — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	12.6	12.7	0.1	13.1	13.2	0.1	13.2	13.3	0.1
Feb	12.6	12.6	0.0	12.8	12.8	0.0	12.9	12.9	0.0
Mar	15.2	15.2	0.0	15.2	15.2	0.0	15.2	15.2	0.0
Apr	18.3	18.3	0.0	18.1	18.1	0.0	18.1	18.1	0.0
May	22.0	22.0	-0.1	21.8	21.8	0.0	21.8	21.8	-0.1
Jun	26.7	26.7	-0.1	26.5	26.5	0.0	26.5	26.4	-0.1
Jul	28.3	28.3	0.0	28.3	28.2	0.0	28.2	28.2	0.0
Aug	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Sep	26.5	26.5	0.0	26.6	26.7	0.0	26.6	26.7	0.0
Oct	22.8	22.9	0.1	23.1	23.1	0.1	23.1	23.2	0.1
Nov	19.0	19.0	0.1	19.3	19.4	0.1	19.4	19.4	0.1
Dec	17.0	17.1	0.1	17.4	17.5	0.0	17.5	17.6	0.1

BatteryIsland — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	13.1	13.2	0.1	13.5	13.5	0.1	13.6	13.7	0.1
Feb	12.8	12.8	0.0	13.0	13.0	0.0	13.1	13.0	0.0
Mar	15.2	15.2	0.0	15.2	15.2	0.0	15.3	15.3	0.0
Apr	18.2	18.2	0.0	18.1	18.1	0.0	18.0	18.0	0.0
May	21.9	21.8	0.0	21.7	21.7	0.0	21.7	21.6	0.0
Jun	26.5	26.5	-0.1	26.4	26.3	0.0	26.3	26.3	0.0
Jul	28.2	28.2	0.0	28.2	28.2	0.0	28.2	28.2	0.0
Aug	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Sep	26.6	26.7	0.0	26.7	26.8	0.0	26.8	26.8	0.0
Oct	23.1	23.1	0.1	23.2	23.3	0.1	23.3	23.4	0.1
Nov	19.3	19.4	0.1	19.6	19.6	0.1	19.7	19.7	0.1
Dec	17.4	17.5	0.1	17.8	17.8	0.0	17.9	17.9	0.0

BaldheadShoalR1 — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	14.0	14.0	0.0	14.4	14.4	0.0	14.5	14.5	0.0
Feb	13.2	13.1	-0.1	13.4	13.3	-0.1	13.4	13.3	-0.1
Mar	15.3	15.3	0.0	15.3	15.3	0.0	15.3	15.3	0.0
Apr	18.0	18.0	0.0	17.8	17.8	0.0	17.8	17.8	0.0
May	21.6	21.6	0.0	21.4	21.4	0.0	21.4	21.4	0.0
Jun	26.1	26.1	0.0	26.0	26.0	0.0	26.0	26.0	0.0
Jul	28.1	28.1	0.0	28.0	28.0	0.0	28.0	28.0	0.0
Aug	28.8	28.8	0.0	28.8	28.8	0.0	28.8	28.8	0.0
Sep	26.9	26.9	0.0	27.0	27.0	0.0	27.0	27.0	0.0
Oct	23.5	23.6	0.0	23.7	23.8	0.0	23.8	23.8	0.0
Nov	19.9	19.9	0.0	20.2	20.2	0.0	20.2	20.2	0.0
Dec	18.1	18.1	0.0	18.5	18.4	0.0	18.6	18.5	0.0

BaldheadShoalR3 — Water Temperature (°C) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	14.9	14.9	0.0	16.0	15.9	-0.1	16.2	16.2	0.0
Feb	13.7	13.6	-0.1	14.0	13.9	-0.1	14.1	14.0	-0.1
Mar	15.3	15.3	0.0	15.2	15.2	0.0	15.2	15.2	0.0
Apr	17.8	17.8	0.0	17.3	17.3	0.0	17.3	17.3	0.0
May	21.2	21.2	0.0	20.7	20.7	0.0	20.6	20.6	0.0
Jun	25.8	25.8	0.0	25.2	25.2	0.0	25.1	25.1	0.0
Jul	27.9	27.9	0.0	27.7	27.7	0.0	27.6	27.6	0.0
Aug	28.8	28.8	0.0	28.7	28.7	0.0	28.7	28.7	0.0
Sep	27.1	27.1	0.0	27.4	27.3	0.0	27.4	27.4	0.0
Oct	23.9	23.9	0.0	24.5	24.5	0.0	24.7	24.6	0.0
Nov	20.5	20.5	0.0	21.2	21.2	0.0	21.4	21.4	0.0
Dec	18.8	18.8	0.0	19.6	19.5	-0.1	19.7	19.7	-0.1

Appendix D–5:
Dissolved Oxygen

BL01 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.5	10.5	0.0	10.5	10.5	0.0	10.5	10.5	0.0	10.5	10.5	0.0	10.5	10.5	0.0	10.4	10.4	0.0	10.4	10.4	0.0	10.4	10.4	0.0	10.3	10.3	0.0
Feb	10.3	10.3	0.0	10.3	10.3	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.2	10.2	0.0	10.1	10.1	0.0	10.1	10.1	0.0	10.0	10.0	0.0
Mar	9.3	9.3	0.0	9.3	9.3	0.0	9.2	9.2	0.0	9.3	9.3	0.0	9.3	9.3	0.0	9.2	9.2	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0
Apr	7.8	7.8	0.0	7.8	7.8	0.0	7.8	7.8	0.0	7.9	7.9	0.0	7.9	7.9	0.0	7.8	7.8	0.0	7.9	7.9	0.0	7.9	7.9	0.0	7.8	7.8	0.0
May	6.0	6.0	0.0	6.0	6.0	0.0	6.0	6.0	0.0	6.1	6.1	0.0	6.1	6.1	0.0	6.0	6.0	0.0	6.3	6.3	0.0	6.3	6.3	0.0	6.3	6.3	0.0
Jun	4.0	4.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0	4.2	4.2	0.0	4.2	4.2	0.0	4.1	4.1	0.0	4.7	4.7	0.0	4.7	4.7	0.0	4.7	4.7	0.0
Jul	3.4	3.4	0.0	3.4	3.4	0.0	3.4	3.4	0.0	3.6	3.6	0.0	3.6	3.6	0.0	3.5	3.6	0.0	4.2	4.2	0.0	4.2	4.2	0.0	4.2	4.2	0.0
Aug	3.9	3.9	0.0	3.9	3.9	0.0	3.9	3.9	0.0	4.1	4.1	0.0	4.1	4.1	0.0	4.0	4.0	0.0	4.6	4.6	0.0	4.6	4.6	0.0	4.6	4.6	0.0
Sep	4.1	4.2	0.0	4.1	4.2	0.0	4.1	4.1	0.0	4.3	4.3	0.0	4.3	4.3	0.0	4.2	4.3	0.0	4.9	4.9	0.0	4.9	4.9	0.0	4.8	4.8	0.0
Oct	5.4	5.4	0.0	5.4	5.4	0.0	5.3	5.4	0.0	5.5	5.5	0.0	5.5	5.5	0.0	5.4	5.5	0.0	6.0	6.0	0.0	6.0	6.0	0.0	5.9	5.9	0.0
Nov	6.8	6.9	0.0	6.8	6.9	0.0	6.8	6.8	0.0	6.9	6.9	0.0	6.9	6.9	0.0	6.9	6.9	0.0	7.2	7.2	0.0	7.2	7.2	0.0	7.2	7.2	0.0
Dec	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.5	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.5	9.5	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.6	0.0

NECF04 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.5	9.5	0.0	9.5	9.5	0.0	9.4	9.4	0.0	9.5	9.5	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0
Feb	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.3	9.4	0.0
Mar	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0	8.6	8.6	0.0
Apr	7.3	7.3	0.0	7.2	7.3	0.0	7.2	7.2	0.0	7.3	7.3	0.0	7.3	7.3	0.0	7.3	7.3	0.0	7.4	7.4	0.0	7.4	7.4	0.0	7.4	7.4	0.0
May	5.7	5.7	0.0	5.7	5.7	0.0	5.6	5.7	0.0	5.8	5.8	0.0	5.8	5.8	0.0	5.7	5.8	0.0	6.1	6.1	0.0	6.1	6.1	0.0	6.1	6.1	0.0
Jun	3.9	4.0	0.1	3.9	3.9	0.1	3.9	3.9	0.1	4.1	4.2	0.1	4.1	4.1	0.1	4.1	4.1	0.1	4.8	4.8	0.1	4.7	4.8	0.1	4.7	4.8	0.1
Jul	3.6	3.7	0.1	3.6	3.6	0.1	3.6	3.6	0.1	3.8	3.8	0.1	3.8	3.8	0.1	3.8	3.8	0.1	4.5	4.5	0.0	4.4	4.5	0.1	4.4	4.4	0.1
Aug	4.2	4.3	0.0	4.2	4.2	0.0	4.2	4.2	0.0	4.4	4.4	0.0	4.3	4.4	0.0	4.3	4.4	0.0	4.8	4.9	0.0	4.8	4.8	0.0	4.8	4.8	0.0
Sep	3.8	3.9	0.1	3.8	3.9	0.1	3.8	3.8	0.1	4.0	4.1	0.1	4.0	4.1	0.1	4.0	4.0	0.1	4.7	4.8	0.0	4.7	4.7	0.1	4.7	4.7	0.1
Oct	4.5	4.5	0.1	4.5	4.5	0.1	4.5	4.5	0.1	4.7	4.7	0.1	4.7	4.7	0.1	4.6	4.7	0.1	5.2	5.3	0.0	5.2	5.3	0.1	5.2	5.2	0.1
Nov	5.3	5.4	0.0	5.3	5.4	0.0	5.3	5.4	0.0	5.5	5.5	0.0	5.5	5.5	0.0	5.5	5.5	0.0	6.0	6.0	0.0	5.9	6.0	0.0	5.9	6.0	0.0
Dec	8.3	8.4	0.0	8.3	8.3	0.0	8.3	8.3	0.0	8.4	8.4	0.0	8.4	8.4	0.0	8.3	8.4	0.0	8.5	8.5	0.0	8.4	8.4	0.0	8.4	8.4	0.0

CFR04 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.8	10.8	0.0	10.8	10.8	0.0	10.8	10.7	0.0	10.8	10.8	0.0	10.7	10.7	0.0	10.7	10.7	0.0	10.7	10.7	0.0	10.6	10.6	0.0	10.6	10.6	0.0
Feb	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0	10.9	10.9	0.0	10.8	10.8	0.0	10.8	10.8	0.0
Mar	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.3	0.0
Apr	8.0	8.0	0.0	8.0	8.0	0.0	8.0	8.0	0.0	8.0	8.0	0.0	8.0	8.0	0.0	8.0	7.9	0.0	7.9	7.9	0.0	7.9	7.9	0.0	7.8	7.8	0.0
May	6.4	6.4	0.0	6.3	6.3	0.0	6.3	6.3	0.0	6.3	6.3	0.0	6.3	6.3	0.0	6.2	6.2	0.0	6.2	6.2	0.0	6.1	6.1	0.0	6.1	6.0	0.0
Jun	5.1	5.1	0.0	5.0	5.0	0.0	5.0	5.0	0.0	5.0	5.0	0.0	4.9	4.9	0.0	4.8	4.8	0.0	4.7	4.7	0.0	4.6	4.5	0.0	4.5	4.5	0.0
Jul	3.6	3.6	0.0	3.5	3.5	0.0	3.5	3.4	0.0	3.4	3.4	0.0	3.3	3.3	0.0	3.2	3.2	0.0	3.0	3.0	0.0	2.9	2.9	0.0	2.8	2.8	0.0
Aug	4.5	4.5	0.0	4.5	4.5	0.0	4.4	4.4	0.0	4.4	4.4	0.0	4.3	4.3	0.0	4.2	4.2	0.0	4.1	4.1	0.0	3.9	3.9	0.0	3.9	3.9	0.0
Sep	4.6	4.6	0.0	4.6	4.5	0.0	4.5	4.5	0.0	4.5	4.5	0.0	4.4	4.4	0.0	4.3	4.3	0.0	4.2	4.2	0.0	4.0	4.0	0.0	4.0	4.0	0.0
Oct	5.7	5.7	0.0	5.7	5.7	0.0	5.6	5.6	0.0	5.6	5.6	0.0	5.5	5.5	0.0	5.5	5.5	0.0	5.3	5.3	0.0	5.2	5.2	0.0	5.2	5.2	0.0
Nov	7.0	7.0	0.0	7.0	7.0	0.0	7.0	6.9	0.0	6.9	6.9	0.0	6.8	6.8	0.0	6.8	6.8	0.0	6.7	6.6	0.0	6.6	6.5	0.0	6.5	6.5	0.0
Dec	9.5	9.5	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.4	9.4	0.0	9.3	9.3	0.0	9.2	9.2	0.0	9.2	9.2	0.0

NECF03 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.9	9.9	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0	10.0	10.0	0.0	10.0	10.0	0.0	9.9	10.0	0.0
Feb	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.9	9.9	0.0	9.8	9.8	0.0	9.8	9.8	0.0
Mar	9.1	9.1	0.0	9.0	9.0	0.0	9.0	9.0	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.1	9.1	0.0
Apr	8.3	8.3	0.0	8.2	8.2	0.0	8.2	8.2	0.0	8.3	8.3	0.0	8.3	8.3	0.0	8.3	8.3	0.0	8.4	8.4	0.0	8.4	8.4	0.0	8.4	8.4	0.0
May	7.5	7.5	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.6	7.6	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.7	7.7	0.0	7.7	7.7	0.0	7.7	7.6	0.0
Jun	6.5	6.5	0.0	6.5	6.5	0.0	6.5	6.4	0.0	6.5	6.5	0.0	6.5	6.5	0.0	6.5	6.5	0.0	6.7	6.7	0.0	6.7	6.7	0.0	6.7	6.7	0.0
Jul	6.0	6.0	0.0	6.0	6.0	0.0	6.0	6.0	0.0	6.1	6.1	0.0	6.1	6.1	0.0	6.1	6.1	0.0	6.4	6.4	0.0	6.4	6.4	0.0	6.4	6.3	0.0
Aug	6.0	6.0	0.0	6.0	6.0	0.0	6.0	6.0	0.0	6.1	6.2	0.0	6.1	6.1	0.0	6.1	6.1	0.0	6.5	6.5	0.0	6.4	6.4	0.0	6.4	6.4	0.0
Sep	6.2	6.2	0.0	6.2	6.2	0.0	6.2	6.2	0.0	6.4	6.4	0.0	6.3	6.4	0.0	6.3	6.3	0.0	6.7	6.7	0.0	6.7	6.7	0.0	6.7	6.7	0.0
Oct	6.9	6.9	0.0	6.8	6.9	0.0	6.8	6.9	0.0	7.1	7.1	0.0	7.0	7.1	0.0	7.0	7.1	0.0	7.4	7.4	0.0	7.4	7.4	0.0	7.4	7.4	0.0
Nov	7.6	7.6	0.0	7.5	7.6	0.0	7.5	7.6	0.0	7.8	7.8	0.0	7.7	7.8	0.0	7.7	7.8	0.0	8.2	8.2	0.0	8.2	8.2	0.0	8.2	8.2	0.0
Dec	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.3	9.3	0.0	9.3	9.3	0.0	9.3	9.3	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0

CFR03 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.7	10.7	0.0	10.7	10.7	0.0	10.7	10.7	0.0	10.7	10.7	0.0	10.6	10.6	0.0	10.6	10.6	0.0	10.5	10.5	0.0	10.5	10.5	0.0	10.4	10.4	0.0
Feb	10.6	10.6	0.0	10.6	10.6	0.0	10.6	10.6	0.0	10.5	10.5	0.0	10.6	10.6	0.0	10.6	10.5	0.0	10.4	10.3	0.0	10.4	10.4	0.0	10.4	10.4	0.0
Mar	9.4	9.4	0.0	9.4	9.4	0.0	9.3	9.3	0.0	9.4	9.4	0.0	9.3	9.3	0.0	9.3	9.3	0.0	9.2	9.2	0.0	9.1	9.1	0.0	9.1	9.1	0.0
Apr	8.2	8.2	0.0	8.1	8.1	0.0	8.1	8.1	0.0	8.2	8.2	0.0	8.1	8.1	0.0	8.1	8.1	0.0	8.1	8.1	0.0	8.0	8.0	0.0	8.0	8.0	0.0
May	6.7	6.8	0.0	6.6	6.6	0.0	6.5	6.6	0.0	6.9	6.9	0.0	6.7	6.7	0.0	6.7	6.7	0.0	6.9	6.9	0.0	6.7	6.8	0.0	6.7	6.7	0.0
Jun	5.4	5.5	0.1	5.3	5.4	0.1	5.3	5.3	0.1	5.7	5.8	0.0	5.6	5.6	0.0	5.5	5.6	0.0	5.9	5.9	0.0	5.7	5.7	0.0	5.7	5.7	0.0
Jul	4.6	4.7	0.1	4.3	4.4	0.1	4.3	4.4	0.1	4.9	5.0	0.1	4.7	4.8	0.1	4.6	4.7	0.1	5.1	5.1	0.0	4.8	4.9	0.0	4.8	4.9	0.0
Aug	5.2	5.2	0.1	5.0	5.1	0.1	4.9	5.0	0.1	5.5	5.5	0.1	5.3	5.3	0.1	5.2	5.3	0.1	5.6	5.6	0.0	5.4	5.4	0.0	5.4	5.4	0.0
Sep	5.3	5.4	0.1	5.1	5.2	0.1	5.1	5.2	0.1	5.6	5.7	0.1	5.5	5.5	0.1	5.4	5.5	0.1	5.8	5.8	0.0	5.6	5.6	0.0	5.6	5.6	0.0
Oct	6.3	6.4	0.1	6.2	6.2	0.1	6.1	6.2	0.1	6.6	6.7	0.0	6.5	6.5	0.1	6.4	6.5	0.0	6.7	6.7	0.0	6.5	6.6	0.0	6.5	6.5	0.0
Nov	7.5	7.5	0.1	7.3	7.4	0.1	7.3	7.3	0.1	7.7	7.8	0.0	7.6	7.6	0.0	7.5	7.6	0.0	7.7	7.7	0.0	7.5	7.5	0.0	7.5	7.5	0.0
Dec	9.7	9.8	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.8	9.8	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.5	9.5	0.0	9.5	9.5	0.0

NECF02 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.8	9.8	0.0	9.7	9.8	0.0	9.7	9.7	0.0	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0	10.0	10.0	0.0	10.0	10.0	0.0	9.9	9.9	0.0
Feb	9.7	9.7	0.0	9.7	9.7	0.0	9.7	9.7	0.0	9.8	9.8	0.0	9.7	9.7	0.0	9.7	9.7	0.0	9.9	9.9	0.0	9.9	9.9	0.0	9.8	9.8	0.0
Mar	9.0	9.0	0.0	9.0	9.0	0.0	9.0	9.0	0.0	9.1	9.1	0.0	9.0	9.0	0.0	9.0	9.0	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.2	0.0
Apr	8.3	8.3	0.0	8.3	8.3	0.0	8.2	8.2	0.0	8.3	8.3	0.0	8.3	8.3	0.0	8.3	8.3	0.0	8.4	8.4	0.0	8.4	8.4	0.0	8.4	8.4	0.0
May	7.5	7.5	0.0	7.5	7.5	0.0	7.5	7.4	0.0	7.6	7.5	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.7	7.6	0.0	7.6	7.6	-0.1	7.6	7.5	-0.1
Jun	6.2	6.1	0.0	6.1	6.1	0.0	6.1	6.1	0.0	6.2	6.2	0.0	6.2	6.2	0.0	6.2	6.1	0.0	6.6	6.5	0.0	6.5	6.5	0.0	6.5	6.5	0.0
Jul	5.8	5.8	0.0	5.7	5.7	0.0	5.7	5.7	0.0	5.9	5.9	0.0	5.8	5.8	0.0	5.8	5.8	0.0	6.3	6.3	0.0	6.2	6.2	0.0	6.2	6.2	0.0
Aug	5.9	5.9	0.0	5.8	5.8	0.0	5.8	5.8	0.0	6.0	6.0	0.0	6.0	6.0	0.0	5.9	5.9	0.0	6.4	6.4	0.0	6.3	6.3	0.0	6.3	6.3	0.0
Sep	6.1	6.1	0.0	6.1	6.1	0.0	6.0	6.0	0.0	6.2	6.2	0.0	6.2	6.2	0.0	6.2	6.2	0.0	6.6	6.6	0.0	6.6	6.6	0.0	6.6	6.5	0.0
Oct	6.8	6.8	0.0	6.8	6.8	0.0	6.8	6.8	0.0	7.0	7.0	0.0	6.9	7.0	0.0	6.9	6.9	0.0	7.4	7.4	0.0	7.3	7.3	0.0	7.3	7.3	0.0
Nov	7.5	7.5	0.0	7.5	7.5	0.0	7.5	7.5	0.0	7.7	7.7	0.0	7.7	7.7	0.0	7.7	7.7	0.0	8.1	8.1	0.0	8.1	8.1	0.0	8.1	8.0	0.0
Dec	9.2	9.2	0.0	9.1	9.2	0.0	9.1	9.1	0.0	9.3	9.3	0.0	9.2	9.3	0.0	9.2	9.2	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.4	0.0

CFR02 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.6	10.6	0.0	10.5	10.5	0.0	10.5	10.5	0.0	10.6	10.6	0.0	10.5	10.5	0.0	10.5	10.5	0.0	10.4	10.4	0.0	10.4	10.4	0.0	10.4	10.4	0.0
Feb	10.5	10.5	0.0	10.5	10.5	0.0	10.4	10.4	0.0	10.5	10.5	0.0	10.4	10.4	0.0	10.4	10.4	0.0	10.3	10.3	0.0	10.3	10.3	0.0	10.2	10.2	0.0
Mar	9.3	9.3	0.0	9.3	9.3	0.0	9.2	9.2	0.0	9.3	9.3	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.2	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0
Apr	8.0	8.0	0.0	8.0	8.0	0.0	7.9	8.0	0.0	8.1	8.1	0.0	8.0	8.1	0.0	8.0	8.0	0.0	8.2	8.2	0.0	8.1	8.1	0.0	8.1	8.1	0.0
May	6.5	6.6	0.0	6.5	6.5	0.0	6.4	6.5	0.0	6.7	6.7	0.0	6.6	6.7	0.0	6.6	6.6	0.0	7.0	7.0	0.0	7.0	7.0	0.0	6.9	6.9	0.0
Jun	5.3	5.3	0.1	5.2	5.3	0.1	5.2	5.2	0.1	5.6	5.6	0.1	5.5	5.6	0.1	5.5	5.6	0.1	6.2	6.2	0.0	6.1	6.1	0.0	6.1	6.1	0.0
Jul	4.3	4.3	0.1	4.2	4.3	0.1	4.1	4.2	0.1	4.7	4.8	0.1	4.6	4.7	0.1	4.6	4.6	0.1	5.5	5.5	0.0	5.4	5.5	0.0	5.4	5.4	0.0
Aug	5.0	5.0	0.1	4.9	5.0	0.1	4.9	4.9	0.1	5.3	5.3	0.1	5.2	5.3	0.1	5.2	5.2	0.1	5.9	5.9	0.0	5.8	5.9	0.0	5.8	5.8	0.0
Sep	5.1	5.2	0.1	5.0	5.1	0.1	5.0	5.1	0.1	5.5	5.5	0.1	5.4	5.5	0.1	5.4	5.4	0.1	6.1	6.2	0.0	6.1	6.1	0.0	6.1	6.1	0.0
Oct	6.1	6.2	0.1	6.1	6.1	0.1	6.0	6.1	0.1	6.4	6.5	0.1	6.4	6.4	0.1	6.3	6.4	0.1	7.0	7.0	0.0	7.0	7.0	0.0	6.9	6.9	0.0
Nov	7.2	7.3	0.1	7.2	7.2	0.1	7.1	7.2	0.1	7.5	7.5	0.1	7.4	7.5	0.1	7.4	7.4	0.1	7.9	7.9	0.0	7.9	7.9	0.0	7.8	7.8	0.0
Dec	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0	9.6	9.6	0.0	9.6	9.6	0.0	9.5	9.6	0.0	9.7	9.7	0.0	9.6	9.6	0.0	9.6	9.6	0.0

CFR01 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.4	10.4	0.0	10.3	10.3	0.0	10.3	10.2	0.0	10.4	10.4	0.0	10.3	10.3	0.0	10.3	10.2	0.0	10.2	10.2	0.0	10.1	10.1	-0.1	10.1	10.0	-0.1
Feb	10.3	10.3	0.0	10.3	10.3	0.0	10.3	10.3	0.0	10.3	10.3	0.0	10.3	10.2	0.0	10.3	10.2	0.0	10.2	10.2	0.0	10.1	10.1	0.0	10.1	10.0	-0.1
Mar	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.0	0.0	9.1	9.1	0.0	9.1	9.0	0.0	9.0	9.0	0.0	9.0	9.0	0.0	9.0	8.9	0.0	8.9	8.9	0.0
Apr	7.9	7.9	0.0	7.8	7.8	0.0	7.8	7.8	0.0	7.9	7.9	0.0	7.9	7.8	0.0	7.8	7.8	0.0	8.0	8.0	0.0	8.0	7.9	0.0	7.9	7.9	0.0
May	6.4	6.4	0.0	6.3	6.4	0.0	6.3	6.3	0.0	6.6	6.6	0.0	6.5	6.5	0.0	6.5	6.5	0.0	6.9	6.9	0.0	6.9	6.9	0.0	6.8	6.8	0.0
Jun	5.2	5.2	0.1	5.1	5.2	0.0	5.1	5.1	0.0	5.5	5.5	0.0	5.4	5.5	0.0	5.4	5.4	0.0	6.1	6.1	0.0	6.0	6.0	0.0	6.0	6.0	0.0
Jul	4.2	4.3	0.1	4.2	4.3	0.1	4.2	4.3	0.1	4.7	4.7	0.1	4.6	4.7	0.1	4.6	4.7	0.1	5.5	5.5	0.0	5.5	5.5	0.0	5.4	5.4	0.0
Aug	4.9	4.9	0.1	4.8	4.8	0.1	4.8	4.8	0.0	5.2	5.2	0.1	5.1	5.2	0.0	5.1	5.1	0.0	5.8	5.8	0.0	5.7	5.7	0.0	5.7	5.7	0.0
Sep	5.0	5.1	0.1	5.0	5.0	0.1	5.0	5.0	0.1	5.4	5.5	0.1	5.3	5.4	0.0	5.3	5.4	0.0	6.1	6.1	0.0	6.0	6.0	0.0	6.0	6.0	0.0
Oct	6.0	6.1	0.1	5.9	6.0	0.0	5.9	5.9	0.0	6.3	6.4	0.1	6.2	6.3	0.0	6.2	6.2	0.0	6.9	6.9	0.0	6.8	6.8	0.0	6.8	6.7	0.0
Nov	7.0	7.1	0.1	6.9	7.0	0.0	6.9	6.9	0.0	7.3	7.3	0.0	7.2	7.2	0.0	7.2	7.2	0.0	7.7	7.7	0.0	7.6	7.6	0.0	7.6	7.5	0.0
Dec	9.3	9.3	0.0	9.2	9.2	0.0	9.2	9.2	0.0	9.4	9.4	0.0	9.3	9.3	0.0	9.3	9.2	0.0	9.5	9.4	0.0	9.3	9.3	0.0	9.3	9.2	-0.1

NECF01 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.7	9.7	-0.1	9.6	9.6	-0.1	9.6	9.5	-0.1	9.7	9.7	-0.1	9.7	9.6	-0.1	9.6	9.5	-0.1	9.8	9.7	-0.1	9.7	9.6	-0.1	9.7	9.6	-0.1
Feb	9.7	9.7	0.0	9.7	9.6	-0.1	9.7	9.6	-0.1	9.7	9.7	0.0	9.7	9.6	-0.1	9.7	9.6	-0.1	9.8	9.7	-0.1	9.7	9.7	-0.1	9.7	9.6	-0.1
Mar	8.9	8.9	0.0	8.9	8.8	-0.1	8.9	8.8	-0.1	9.0	8.9	-0.1	8.9	8.8	-0.1	8.9	8.8	-0.1	9.0	9.0	-0.1	8.9	8.9	-0.1	8.9	8.8	-0.1
Apr	8.0	8.0	-0.1	7.9	7.8	-0.1	7.9	7.8	-0.1	8.1	8.0	-0.1	7.9	7.9	-0.1	7.9	7.8	-0.1	8.1	8.1	-0.1	8.0	8.0	-0.1	8.0	7.9	-0.1
May	7.0	7.0	-0.1	6.9	6.8	-0.1	6.9	6.7	-0.1	7.1	7.0	-0.1	7.0	6.9	-0.1	6.9	6.8	-0.1	7.2	7.1	-0.1	7.1	7.0	-0.1	7.1	7.0	-0.1
Jun	5.7	5.7	0.0	5.6	5.5	-0.1	5.5	5.5	-0.1	5.9	5.8	0.0	5.7	5.7	0.0	5.7	5.6	-0.1	6.2	6.1	-0.1	6.1	6.1	-0.1	6.1	6.0	-0.1
Jul	5.2	5.2	0.0	5.1	5.1	0.0	5.0	5.0	-0.1	5.4	5.4	0.0	5.3	5.3	0.0	5.2	5.2	0.0	5.8	5.8	0.0	5.8	5.7	0.0	5.7	5.7	0.0
Aug	5.5	5.4	0.0	5.3	5.3	0.0	5.3	5.2	-0.1	5.6	5.6	0.0	5.5	5.5	0.0	5.4	5.4	0.0	6.0	5.9	0.0	5.9	5.8	-0.1	5.8	5.8	-0.1
Sep	5.7	5.7	0.0	5.6	5.5	0.0	5.5	5.5	-0.1	5.9	5.8	0.0	5.7	5.7	0.0	5.7	5.7	0.0	6.2	6.2	0.0	6.1	6.1	-0.1	6.1	6.1	-0.1
Oct	6.5	6.4	0.0	6.3	6.3	-0.1	6.3	6.2	-0.1	6.6	6.6	0.0	6.5	6.5	0.0	6.5	6.4	-0.1	6.9	6.9	-0.1	6.9	6.8	-0.1	6.8	6.8	-0.1
Nov	7.2	7.2	0.0	7.1	7.1	-0.1	7.1	7.0	-0.1	7.4	7.4	0.0	7.3	7.2	-0.1	7.2	7.2	-0.1	7.7	7.6	-0.1	7.6	7.5	-0.1	7.6	7.5	-0.1
Dec	9.0	9.0	-0.1	8.9	8.8	-0.1	8.9	8.8	-0.1	9.1	9.0	-0.1	9.0	8.9	-0.1	8.9	8.9	-0.1	9.2	9.1	-0.1	9.1	9.0	-0.1	9.1	9.0	-0.1

Battleship — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.8	9.8	0.0	9.5	9.3	-0.2	9.2	9.0	-0.3	9.8	9.8	0.0	9.5	9.3	-0.2	9.3	9.0	-0.2	9.8	9.7	-0.1	9.5	9.4	-0.1	9.3	9.2	-0.2
Feb	9.9	9.8	0.0	9.6	9.4	-0.2	9.4	9.1	-0.3	9.9	9.8	-0.1	9.6	9.4	-0.2	9.4	9.2	-0.3	9.8	9.8	-0.1	9.6	9.4	-0.1	9.4	9.2	-0.2
Mar	8.8	8.8	0.0	8.6	8.4	-0.2	8.4	8.1	-0.3	8.8	8.8	0.0	8.6	8.4	-0.2	8.4	8.2	-0.2	8.8	8.8	0.0	8.6	8.5	-0.1	8.5	8.4	-0.1
Apr	7.7	7.7	0.0	7.5	7.3	-0.1	7.2	7.1	-0.2	7.8	7.7	0.0	7.5	7.4	-0.1	7.3	7.2	-0.2	7.9	7.9	0.0	7.7	7.6	-0.1	7.6	7.5	-0.1
May	6.5	6.5	0.0	6.3	6.3	-0.1	6.2	6.1	-0.1	6.6	6.6	0.0	6.5	6.4	-0.1	6.3	6.2	-0.1	6.9	6.9	0.0	6.8	6.7	-0.1	6.7	6.6	-0.1
Jun	5.3	5.3	0.0	5.2	5.1	-0.1	5.1	5.0	-0.1	5.6	5.5	0.0	5.4	5.4	-0.1	5.3	5.3	-0.1	6.0	6.0	0.0	5.9	5.8	-0.1	5.8	5.7	-0.1
Jul	4.6	4.6	0.0	4.6	4.5	0.0	4.5	4.4	-0.1	4.9	4.9	0.0	4.9	4.8	0.0	4.8	4.7	-0.1	5.6	5.5	0.0	5.5	5.4	-0.1	5.4	5.3	-0.1
Aug	5.0	5.0	0.0	4.9	4.8	-0.1	4.7	4.7	-0.1	5.3	5.2	0.0	5.1	5.1	0.0	5.0	4.9	-0.1	5.7	5.7	0.0	5.6	5.5	-0.1	5.5	5.4	-0.1
Sep	5.2	5.2	0.0	5.1	5.1	0.0	5.0	4.9	-0.1	5.5	5.5	0.0	5.4	5.3	0.0	5.3	5.2	-0.1	6.0	6.0	0.0	5.9	5.8	-0.1	5.8	5.7	-0.1
Oct	6.0	6.0	0.0	5.9	5.8	-0.1	5.8	5.7	-0.1	6.3	6.3	0.0	6.1	6.1	-0.1	6.0	5.9	-0.1	6.7	6.7	0.0	6.6	6.5	-0.1	6.5	6.4	-0.1
Nov	6.9	6.9	0.0	6.7	6.6	-0.1	6.6	6.5	-0.1	7.1	7.1	0.0	6.9	6.9	-0.1	6.8	6.7	-0.1	7.5	7.4	-0.1	7.3	7.2	-0.1	7.2	7.1	-0.1
Dec	8.9	8.9	0.0	8.5	8.4	-0.1	8.3	8.2	-0.2	9.0	8.9	0.0	8.6	8.5	-0.1	8.4	8.3	-0.1	9.1	9.0	-0.1	8.8	8.7	-0.1	8.6	8.5	-0.1

LowerAnchorageBasin — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.7	9.6	-0.1	9.2	9.0	-0.3	8.7	8.5	-0.1	9.7	9.6	-0.1	9.2	9.0	-0.2	8.7	8.6	-0.1	9.7	9.6	-0.1	9.3	9.1	-0.2	8.8	8.8	0.0
Feb	9.8	9.7	-0.1	9.4	9.1	-0.3	8.8	8.7	-0.2	9.8	9.7	-0.1	9.4	9.2	-0.2	8.8	8.7	-0.1	9.7	9.7	0.0	9.4	9.2	-0.2	8.9	8.9	0.0
Mar	8.7	8.7	0.0	8.3	8.1	-0.2	7.7	7.6	-0.1	8.7	8.7	0.0	8.3	8.2	-0.2	7.8	7.8	0.0	8.8	8.8	0.0	8.5	8.3	-0.1	8.0	8.0	0.0
Apr	7.7	7.6	0.0	7.2	7.1	-0.2	6.8	6.8	0.0	7.7	7.7	-0.1	7.3	7.2	-0.2	6.9	6.9	0.0	7.9	7.9	-0.1	7.6	7.5	-0.1	7.3	7.3	0.0
May	6.5	6.5	0.0	6.2	6.1	-0.1	5.9	5.9	0.0	6.7	6.6	0.0	6.3	6.2	-0.1	6.1	6.1	0.1	6.9	6.9	0.0	6.7	6.6	-0.1	6.5	6.5	0.1
Jun	5.4	5.3	0.0	5.1	5.1	-0.1	5.0	5.0	0.0	5.6	5.5	0.0	5.4	5.3	-0.1	5.2	5.2	0.0	6.0	6.0	-0.1	5.8	5.7	-0.1	5.6	5.7	0.1
Jul	4.7	4.7	0.0	4.5	4.4	-0.1	4.4	4.4	0.1	5.0	5.0	0.0	4.8	4.7	-0.1	4.6	4.7	0.1	5.6	5.5	0.0	5.4	5.3	-0.1	5.2	5.2	0.1
Aug	5.0	5.0	0.0	4.8	4.7	-0.1	4.6	4.6	0.0	5.3	5.2	0.0	5.0	4.9	-0.1	4.8	4.8	0.1	5.7	5.7	0.0	5.5	5.4	-0.1	5.2	5.3	0.1
Sep	5.2	5.2	0.0	5.0	4.9	-0.1	4.8	4.9	0.0	5.5	5.5	0.0	5.3	5.2	-0.1	5.1	5.1	0.1	6.0	5.9	0.0	5.8	5.7	-0.1	5.5	5.6	0.1
Oct	6.0	6.0	0.0	5.8	5.7	-0.1	5.6	5.6	0.0	6.3	6.2	0.0	6.0	5.9	-0.1	5.8	5.8	0.0	6.7	6.6	-0.1	6.4	6.4	-0.1	6.2	6.2	0.0
Nov	6.9	6.8	0.0	6.6	6.5	-0.1	6.3	6.3	0.0	7.1	7.0	0.0	6.8	6.7	-0.1	6.5	6.5	0.0	7.4	7.4	-0.1	7.1	7.0	-0.1	6.8	6.9	0.0
Dec	8.8	8.7	-0.1	8.3	8.1	-0.2	7.9	7.8	0.0	8.9	8.8	-0.1	8.4	8.3	-0.2	8.0	8.0	0.0	9.0	8.9	-0.1	8.6	8.5	-0.1	8.2	8.2	0.0

LowerBigIsland — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									**RSLR Intermediate**									**RSLR High**								
	Surface			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**			**Surface**			**Middle**			**Bottom**		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.5	9.4	-0.1	9.1	8.9	-0.2	9.0	8.7	-0.3	9.5	9.4	-0.1	9.2	9.0	-0.2	9.0	8.8	-0.2	9.4	9.4	-0.1	9.1	9.0	-0.1	9.0	8.8	-0.2
Feb	9.7	9.6	-0.1	9.3	9.1	-0.2	9.2	8.9	-0.3	9.7	9.6	-0.1	9.3	9.1	-0.2	9.2	8.9	-0.3	9.6	9.5	-0.1	9.3	9.1	-0.1	9.1	8.9	-0.2
Mar	8.7	8.6	-0.1	8.4	8.2	-0.2	8.3	8.1	-0.2	8.7	8.7	-0.1	8.4	8.3	-0.2	8.3	8.1	-0.2	8.8	8.7	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.1
Apr	7.8	7.8	-0.1	7.5	7.4	-0.2	7.5	7.3	-0.2	7.9	7.8	-0.1	7.6	7.5	-0.2	7.5	7.4	-0.2	7.9	7.9	-0.1	7.8	7.7	-0.1	7.7	7.6	-0.1
May	6.8	6.7	-0.1	6.6	6.5	-0.1	6.6	6.5	-0.1	6.9	6.8	-0.1	6.7	6.6	-0.1	6.7	6.6	-0.1	7.1	7.0	-0.1	6.9	6.8	-0.1	6.9	6.8	-0.1
Jun	5.8	5.7	-0.1	5.7	5.6	-0.1	5.7	5.5	-0.1	5.9	5.8	-0.1	5.8	5.7	-0.1	5.8	5.7	-0.1	6.1	6.1	-0.1	6.0	5.9	-0.1	6.0	5.9	-0.1
Jul	5.2	5.1	-0.1	5.1	5.0	-0.1	5.1	5.0	-0.1	5.4	5.3	-0.1	5.3	5.2	-0.1	5.2	5.1	-0.1	5.7	5.6	-0.1	5.6	5.5	-0.1	5.5	5.4	-0.1
Aug	5.3	5.3	-0.1	5.2	5.1	-0.1	5.2	5.0	-0.1	5.5	5.4	-0.1	5.3	5.2	-0.1	5.3	5.2	-0.1	5.7	5.7	-0.1	5.6	5.5	-0.1	5.5	5.4	-0.1
Sep	5.6	5.5	-0.1	5.4	5.3	-0.1	5.4	5.3	-0.1	5.7	5.7	-0.1	5.6	5.5	-0.1	5.6	5.4	-0.1	6.0	5.9	-0.1	5.8	5.7	-0.1	5.8	5.7	-0.1
Oct	6.2	6.2	-0.1	6.1	6.0	-0.1	6.1	6.0	-0.1	6.4	6.3	-0.1	6.2	6.1	-0.1	6.2	6.1	-0.1	6.6	6.6	-0.1	6.5	6.4	-0.1	6.4	6.3	-0.1
Nov	7.0	6.9	-0.1	6.8	6.7	-0.1	6.8	6.6	-0.1	7.1	7.0	-0.1	6.9	6.8	-0.1	6.9	6.8	-0.1	7.3	7.2	-0.1	7.1	7.0	-0.1	7.0	6.9	-0.1
Dec	8.7	8.6	-0.1	8.4	8.2	-0.2	8.3	8.1	-0.2	8.8	8.7	-0.1	8.4	8.3	-0.2	8.3	8.2	-0.2	8.8	8.7	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.2

LowerLilliput — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.5	9.4	-0.1	9.0	8.8	-0.2	8.8	8.6	-0.2	9.5	9.4	-0.1	8.9	8.8	-0.2	8.8	8.6	-0.2	9.4	9.3	-0.1	8.9	8.8	-0.2	8.8	8.6	-0.2
Feb	9.7	9.6	-0.1	9.2	9.0	-0.2	9.0	8.8	-0.2	9.7	9.6	-0.1	9.1	8.9	-0.2	9.0	8.8	-0.2	9.6	9.5	-0.1	9.1	8.9	-0.1	9.0	8.8	-0.2
Mar	8.9	8.9	-0.1	8.5	8.4	-0.2	8.4	8.3	-0.2	8.9	8.9	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.2	8.9	8.8	-0.1	8.5	8.4	-0.1	8.5	8.3	-0.1
Apr	8.1	8.1	-0.1	7.8	7.6	-0.1	7.7	7.6	-0.1	8.1	8.1	-0.1	7.8	7.7	-0.1	7.8	7.6	-0.1	8.1	8.1	-0.1	7.8	7.7	-0.1	7.8	7.7	-0.1
May	7.1	7.1	-0.1	6.9	6.8	-0.1	6.9	6.8	-0.1	7.2	7.1	-0.1	7.0	6.9	-0.1	7.0	6.9	-0.1	7.2	7.2	-0.1	7.1	7.0	-0.1	7.0	7.0	-0.1
Jun	6.1	6.1	-0.1	6.0	5.9	-0.1	6.0	5.9	-0.1	6.2	6.1	-0.1	6.1	6.0	-0.1	6.0	6.0	-0.1	6.3	6.2	-0.1	6.1	6.0	-0.1	6.1	6.0	-0.1
Jul	5.6	5.5	-0.1	5.5	5.4	-0.1	5.5	5.4	-0.1	5.7	5.6	-0.1	5.5	5.4	-0.1	5.5	5.4	-0.1	5.8	5.8	-0.1	5.7	5.6	-0.1	5.6	5.5	-0.1
Aug	5.6	5.5	-0.1	5.4	5.3	-0.1	5.4	5.3	-0.1	5.7	5.6	-0.1	5.5	5.4	-0.1	5.5	5.4	-0.1	5.8	5.7	-0.1	5.6	5.5	-0.1	5.6	5.5	-0.1
Sep	5.8	5.8	-0.1	5.7	5.5	-0.1	5.6	5.5	-0.1	5.9	5.9	-0.1	5.7	5.6	-0.1	5.7	5.6	-0.1	6.0	6.0	-0.1	5.8	5.7	-0.1	5.8	5.7	-0.1
Oct	6.5	6.4	-0.1	6.3	6.2	-0.1	6.2	6.1	-0.1	6.5	6.5	-0.1	6.3	6.2	-0.1	6.3	6.2	-0.1	6.6	6.6	-0.1	6.4	6.3	-0.1	6.4	6.3	-0.1
Nov	7.1	7.1	-0.1	6.9	6.8	-0.1	6.9	6.8	-0.1	7.2	7.1	-0.1	7.0	6.9	-0.1	6.9	6.8	-0.1	7.3	7.2	-0.1	7.0	6.9	-0.1	7.0	6.9	-0.1
Dec	8.8	8.7	-0.1	8.3	8.1	-0.2	8.2	8.1	-0.2	8.8	8.7	-0.1	8.3	8.2	-0.1	8.3	8.1	-0.2	8.7	8.6	-0.1	8.3	8.2	-0.1	8.2	8.1	-0.1

LowerMidnight — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.3	9.2	-0.1	8.6	8.5	-0.1	8.5	8.3	-0.2	9.2	9.1	-0.1	8.6	8.5	-0.1	8.5	8.3	-0.1	9.1	9.0	-0.1	8.6	8.5	-0.1	8.5	8.3	-0.1
Feb	9.5	9.4	-0.1	8.9	8.7	-0.1	8.7	8.5	-0.2	9.5	9.4	-0.1	8.8	8.7	-0.1	8.7	8.5	-0.2	9.3	9.2	-0.1	8.8	8.6	-0.1	8.6	8.5	-0.1
Mar	8.9	8.9	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.1	8.9	8.9	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.1	8.8	8.8	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.1
Apr	8.2	8.2	-0.1	7.9	7.8	-0.1	7.8	7.7	-0.1	8.2	8.1	-0.1	7.9	7.8	-0.1	7.8	7.7	-0.1	8.1	8.1	-0.1	7.8	7.8	-0.1	7.8	7.7	-0.1
May	7.3	7.3	-0.1	7.1	7.0	-0.1	7.0	7.0	-0.1	7.3	7.3	-0.1	7.1	7.0	-0.1	7.1	7.0	-0.1	7.3	7.3	-0.1	7.1	7.1	-0.1	7.1	7.0	-0.1
Jun	6.3	6.3	-0.1	6.2	6.1	-0.1	6.1	6.0	-0.1	6.3	6.3	-0.1	6.2	6.1	-0.1	6.1	6.1	-0.1	6.3	6.2	-0.1	6.1	6.1	-0.1	6.1	6.0	-0.1
Jul	5.8	5.7	-0.1	5.6	5.5	-0.1	5.6	5.5	-0.1	5.8	5.8	-0.1	5.6	5.6	-0.1	5.6	5.5	-0.1	5.8	5.8	-0.1	5.6	5.6	-0.1	5.6	5.5	-0.1
Aug	5.7	5.7	-0.1	5.5	5.4	-0.1	5.4	5.3	-0.1	5.7	5.7	-0.1	5.5	5.4	-0.1	5.5	5.4	-0.1	5.7	5.7	-0.1	5.5	5.4	-0.1	5.5	5.4	-0.1
Sep	5.9	5.8	-0.1	5.7	5.6	-0.1	5.6	5.5	-0.1	5.9	5.9	-0.1	5.7	5.6	-0.1	5.7	5.6	-0.1	5.9	5.9	-0.1	5.7	5.6	-0.1	5.6	5.6	-0.1
Oct	6.5	6.4	-0.1	6.2	6.1	-0.1	6.2	6.1	-0.1	6.5	6.5	-0.1	6.3	6.2	-0.1	6.2	6.1	-0.1	6.5	6.4	-0.1	6.3	6.2	-0.1	6.2	6.2	-0.1
Nov	7.1	7.0	-0.1	6.8	6.7	-0.1	6.8	6.7	-0.1	7.1	7.1	-0.1	6.9	6.8	-0.1	6.8	6.7	-0.1	7.1	7.0	-0.1	6.8	6.7	-0.1	6.8	6.7	-0.1
Dec	8.6	8.5	-0.1	8.1	8.0	-0.1	8.0	7.8	-0.1	8.6	8.5	-0.1	8.1	8.0	-0.1	8.0	7.9	-0.1	8.5	8.4	-0.1	8.0	7.9	-0.1	7.9	7.8	-0.1

SnowMarsh — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.8	8.7	-0.1	8.1	8.1	-0.1	8.0	7.8	-0.1	8.8	8.7	-0.1	8.1	8.1	-0.1	8.0	7.9	-0.1	8.7	8.6	-0.1	8.2	8.1	-0.1	8.0	7.9	-0.1
Feb	9.1	9.0	-0.1	8.4	8.3	-0.1	8.2	8.1	-0.1	9.1	9.0	-0.1	8.4	8.3	-0.1	8.2	8.1	-0.1	9.0	8.9	-0.1	8.3	8.2	-0.1	8.2	8.1	-0.1
Mar	8.8	8.8	-0.1	8.3	8.2	-0.1	8.1	8.0	-0.1	8.8	8.7	-0.1	8.3	8.2	-0.1	8.2	8.1	-0.1	8.7	8.7	-0.1	8.2	8.2	-0.1	8.1	8.1	-0.1
Apr	8.1	8.1	-0.1	7.7	7.6	-0.1	7.6	7.5	-0.1	8.1	8.1	-0.1	7.7	7.7	-0.1	7.6	7.5	-0.1	8.1	8.0	-0.1	7.7	7.7	-0.1	7.6	7.6	-0.1
May	7.3	7.3	-0.1	7.0	6.9	-0.1	6.9	6.8	-0.1	7.3	7.3	-0.1	7.0	7.0	-0.1	6.9	6.9	-0.1	7.4	7.3	-0.1	7.1	7.0	-0.1	7.0	6.9	-0.1
Jun	6.4	6.3	-0.1	6.1	6.0	-0.1	6.0	5.9	-0.1	6.4	6.3	-0.1	6.1	6.0	-0.1	6.0	5.9	-0.1	6.3	6.3	-0.1	6.0	6.0	-0.1	6.0	5.9	-0.1
Jul	5.8	5.7	-0.1	5.5	5.4	-0.1	5.4	5.3	-0.1	5.8	5.7	-0.1	5.5	5.4	-0.1	5.4	5.4	-0.1	5.8	5.7	-0.1	5.5	5.4	-0.1	5.4	5.4	-0.1
Aug	5.6	5.6	-0.1	5.3	5.2	-0.1	5.2	5.1	-0.1	5.7	5.6	-0.1	5.3	5.3	-0.1	5.3	5.2	-0.1	5.6	5.6	-0.1	5.3	5.2	-0.1	5.2	5.2	-0.1
Sep	5.8	5.7	-0.1	5.4	5.4	-0.1	5.3	5.3	-0.1	5.8	5.8	-0.1	5.5	5.4	-0.1	5.4	5.3	-0.1	5.8	5.7	-0.1	5.4	5.4	-0.1	5.4	5.3	-0.1
Oct	6.3	6.3	-0.1	6.0	5.9	-0.1	5.9	5.8	-0.1	6.4	6.3	-0.1	6.0	6.0	0.0	5.9	5.9	-0.1	6.4	6.3	-0.1	6.0	6.0	-0.1	6.0	5.9	-0.1
Nov	6.9	6.8	-0.1	6.5	6.5	-0.1	6.4	6.4	-0.1	6.9	6.9	-0.1	6.6	6.5	0.0	6.5	6.4	-0.1	6.9	6.8	-0.1	6.5	6.5	-0.1	6.4	6.4	-0.1
Dec	8.2	8.1	-0.1	7.7	7.6	-0.1	7.5	7.4	-0.1	8.2	8.1	-0.1	7.7	7.6	-0.1	7.6	7.5	-0.1	8.1	8.0	-0.1	7.6	7.6	-0.1	7.5	7.5	-0.1

BatteryIsland — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.5	8.4	-0.1	7.8	7.8	0.0	7.7	7.6	-0.1	8.4	8.4	-0.1	7.9	7.8	0.0	7.7	7.6	-0.1	8.4	8.3	-0.1	7.9	7.9	-0.1	7.8	7.7	-0.1
Feb	8.8	8.7	0.0	8.1	8.1	0.0	7.9	7.8	-0.1	8.7	8.7	0.0	8.1	8.1	0.0	7.9	7.9	-0.1	8.6	8.6	0.0	8.1	8.1	-0.1	7.9	7.9	-0.1
Mar	8.6	8.6	0.0	8.1	8.1	0.0	8.0	7.9	-0.1	8.6	8.6	0.0	8.1	8.1	0.0	8.0	7.9	-0.1	8.5	8.5	0.0	8.1	8.1	0.0	8.0	7.9	-0.1
Apr	8.0	8.0	0.0	7.6	7.6	0.0	7.5	7.4	-0.1	8.0	8.0	0.0	7.6	7.6	0.0	7.5	7.4	-0.1	8.0	7.9	0.0	7.6	7.6	-0.1	7.5	7.5	-0.1
May	7.3	7.2	0.0	6.9	6.8	0.0	6.8	6.7	-0.1	7.2	7.2	0.0	6.9	6.9	0.0	6.8	6.7	-0.1	7.3	7.2	0.0	7.0	6.9	-0.1	6.9	6.9	-0.1
Jun	6.3	6.2	0.0	5.9	5.9	0.0	5.8	5.8	0.0	6.3	6.2	0.0	6.0	5.9	0.0	5.8	5.8	0.0	6.2	6.1	-0.1	5.9	5.9	0.0	5.8	5.8	0.0
Jul	5.7	5.6	-0.1	5.3	5.3	0.0	5.2	5.2	-0.1	5.7	5.6	-0.1	5.4	5.3	0.0	5.3	5.2	-0.1	5.6	5.6	-0.1	5.4	5.3	0.0	5.3	5.2	-0.1
Aug	5.5	5.4	-0.1	5.1	5.1	0.0	5.0	5.0	-0.1	5.5	5.5	0.0	5.2	5.1	0.0	5.1	5.0	-0.1	5.4	5.4	-0.1	5.2	5.1	0.0	5.1	5.0	0.0
Sep	5.6	5.6	-0.1	5.2	5.2	0.0	5.1	5.1	-0.1	5.6	5.6	0.0	5.3	5.3	0.0	5.2	5.1	-0.1	5.6	5.5	-0.1	5.3	5.3	0.0	5.2	5.1	0.0
Oct	6.1	6.1	-0.1	5.8	5.7	0.0	5.7	5.6	-0.1	6.2	6.1	0.0	5.8	5.8	0.0	5.7	5.7	0.0	6.2	6.1	-0.1	5.9	5.9	0.0	5.8	5.8	0.0
Nov	6.7	6.6	-0.1	6.3	6.3	0.0	6.2	6.2	-0.1	6.7	6.7	0.0	6.4	6.4	0.0	6.3	6.2	0.0	6.6	6.6	-0.1	6.4	6.3	0.0	6.3	6.2	0.0
Dec	7.9	7.8	-0.1	7.4	7.4	0.0	7.2	7.2	-0.1	7.9	7.9	-0.1	7.4	7.4	0.0	7.3	7.3	-0.1	7.8	7.8	0.0	7.4	7.4	0.0	7.3	7.3	-0.1

BaldheadShoalR1 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.9	7.9	0.0	7.1	7.1	0.0	6.9	6.9	0.0	7.9	7.9	0.0	7.2	7.2	0.0	7.0	7.0	0.0	7.9	7.9	0.0	7.4	7.4	-0.1	7.2	7.2	0.0
Feb	8.3	8.3	0.0	7.4	7.4	0.0	7.0	7.0	0.0	8.3	8.3	0.0	7.4	7.4	0.0	7.1	7.1	0.0	8.2	8.2	0.0	7.6	7.6	0.0	7.3	7.3	0.0
Mar	8.3	8.3	0.0	7.6	7.6	0.0	7.3	7.3	0.0	8.3	8.3	0.0	7.7	7.6	0.0	7.4	7.4	0.0	8.2	8.2	0.0	7.7	7.7	0.0	7.5	7.5	0.0
Apr	7.7	7.7	0.0	7.1	7.1	0.0	6.9	6.9	0.0	7.7	7.7	0.0	7.2	7.2	0.0	7.0	7.0	0.0	7.7	7.7	0.0	7.3	7.3	0.0	7.1	7.1	0.0
May	6.9	6.9	0.0	6.4	6.4	0.0	6.2	6.2	0.0	6.9	6.9	0.0	6.5	6.5	0.0	6.3	6.3	0.0	7.0	6.9	0.0	6.7	6.7	0.0	6.6	6.6	0.0
Jun	5.9	5.9	0.0	5.5	5.5	0.0	5.3	5.4	0.1	5.9	5.9	0.0	5.5	5.5	0.0	5.4	5.4	0.1	5.8	5.8	0.0	5.6	5.6	0.0	5.5	5.5	0.0
Jul	5.2	5.2	0.0	4.8	4.8	0.0	4.7	4.7	0.0	5.3	5.3	0.0	4.9	4.9	0.0	4.8	4.8	0.0	5.2	5.2	0.0	5.0	5.0	0.0	4.9	5.0	0.0
Aug	5.0	5.0	0.0	4.6	4.6	0.0	4.5	4.5	0.0	5.1	5.1	0.0	4.7	4.7	0.0	4.6	4.6	0.0	5.0	5.0	0.0	4.8	4.7	0.0	4.7	4.7	0.0
Sep	5.1	5.1	0.0	4.7	4.7	0.0	4.5	4.6	0.0	5.2	5.2	0.0	4.8	4.8	0.0	4.6	4.7	0.1	5.1	5.1	0.0	4.9	4.9	0.0	4.8	4.8	0.0
Oct	5.6	5.7	0.0	5.2	5.2	0.0	5.1	5.1	0.0	5.7	5.7	0.0	5.3	5.3	0.0	5.2	5.2	0.1	5.7	5.7	0.0	5.5	5.5	0.0	5.4	5.5	0.0
Nov	6.2	6.2	0.0	5.8	5.8	0.0	5.6	5.7	0.0	6.2	6.3	0.0	5.9	5.9	0.0	5.7	5.8	0.1	6.1	6.2	0.0	5.9	5.9	0.0	5.8	5.9	0.0
Dec	7.4	7.4	0.0	6.8	6.8	0.0	6.5	6.5	0.0	7.4	7.4	0.0	6.9	6.9	0.0	6.6	6.7	0.0	7.3	7.3	0.0	7.0	7.0	0.0	6.8	6.8	0.0

BaldheadShoalR3 — Dissolved Oxygen (mg/L) Comparison for Typical Year

	RSLR Low									RSLR Intermediate									RSLR High								
	Surface			Middle			Bottom			Surface			Middle			Bottom			Surface			Middle			Bottom		
	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.2	7.1	0.0	5.4	5.5	0.1	5.3	5.4	0.1	7.2	7.2	0.0	5.6	5.6	0.0	5.5	5.5	0.1	7.3	7.2	-0.1	6.1	6.0	-0.1	6.0	5.8	-0.1
Feb	7.5	7.5	-0.1	5.6	5.6	0.1	5.4	5.5	0.1	7.5	7.5	0.0	5.7	5.8	0.1	5.6	5.6	0.1	7.6	7.5	-0.1	6.0	6.0	0.0	5.9	5.9	0.0
Mar	7.8	7.8	-0.1	6.2	6.3	0.1	6.1	6.2	0.1	7.8	7.8	0.0	6.3	6.4	0.1	6.2	6.3	0.1	7.8	7.8	0.0	6.5	6.5	0.0	6.4	6.4	0.0
Apr	7.3	7.2	-0.1	5.5	5.6	0.1	5.4	5.5	0.1	7.3	7.2	-0.1	5.6	5.7	0.0	5.5	5.6	0.0	7.3	7.2	-0.1	5.9	5.9	0.0	5.8	5.8	0.0
May	6.4	6.4	0.0	4.6	4.7	0.1	4.5	4.6	0.1	6.4	6.4	-0.1	4.8	4.8	0.0	4.6	4.7	0.0	6.6	6.5	-0.1	5.4	5.4	0.0	5.3	5.3	0.0
Jun	5.3	5.3	0.0	3.8	3.9	0.0	3.7	3.7	0.0	5.3	5.3	0.0	3.9	4.0	0.1	3.8	3.8	0.0	5.2	5.2	-0.1	4.4	4.5	0.0	4.4	4.4	0.0
Jul	4.6	4.6	0.0	3.2	3.2	0.0	3.0	3.1	0.0	4.6	4.6	0.0	3.3	3.4	0.1	3.2	3.2	0.0	4.6	4.6	-0.1	3.9	4.0	0.0	3.9	3.9	0.0
Aug	4.4	4.4	0.0	3.1	3.1	0.0	2.9	2.9	0.0	4.4	4.4	0.0	3.2	3.2	0.1	3.1	3.1	0.0	4.4	4.3	0.0	3.7	3.7	0.0	3.6	3.6	0.0
Sep	4.5	4.4	0.0	3.1	3.1	0.0	3.0	3.0	0.0	4.5	4.5	0.0	3.3	3.3	0.1	3.1	3.2	0.0	4.5	4.5	0.0	3.8	3.8	0.0	3.7	3.8	0.0
Oct	5.0	4.9	0.0	3.7	3.7	0.0	3.5	3.5	0.0	5.0	5.0	0.0	3.9	3.9	0.1	3.7	3.8	0.1	5.2	5.2	0.0	4.7	4.7	0.0	4.6	4.6	0.0
Nov	5.5	5.5	0.0	4.3	4.3	0.0	4.2	4.2	0.0	5.6	5.6	0.0	4.5	4.6	0.1	4.4	4.5	0.1	5.6	5.6	0.0	5.0	5.1	0.0	5.0	5.0	0.0
Dec	6.7	6.6	0.0	5.0	5.1	0.1	4.9	4.9	0.1	6.7	6.7	0.0	5.3	5.3	0.1	5.1	5.2	0.1	6.7	6.7	0.0	5.6	5.6	0.0	5.5	5.5	0.0

BL01 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.1	10.1	0.0	10.1	10.1	0.0	10.1	10.1	0.0
Feb	9.5	9.5	0.0	9.5	9.5	0.0	9.5	9.5	0.0
Mar	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0
Apr	8.0	8.0	0.0	8.0	8.0	0.0	8.0	8.0	0.0
May	5.4	5.4	0.0	5.4	5.4	0.0	5.3	5.3	0.0
Jun	4.1	4.1	0.0	4.1	4.1	0.0	4.1	4.1	0.0
Jul	5.1	5.1	0.0	5.1	5.1	0.0	5.1	5.0	0.0
Aug	5.2	5.2	0.0	5.2	5.2	0.0	5.2	5.2	0.0
Sep	4.4	4.4	0.0	4.4	4.4	0.0	4.4	4.4	0.0
Oct	5.4	5.3	0.0	5.4	5.3	0.0	5.3	5.3	0.0
Nov	6.9	6.9	0.0	6.9	6.9	0.0	6.9	6.9	0.0
Dec	8.8	8.8	0.0	8.8	8.8	0.0	8.8	8.8	0.0

NECF04 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.1	10.1	0.0	10.0	10.1	0.0	10.0	10.0	0.0
Feb	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0
Mar	8.3	8.3	0.0	8.3	8.3	0.0	8.3	8.3	0.0
Apr	8.2	8.2	0.0	8.2	8.2	0.0	8.2	8.2	0.0
May	7.8	7.8	0.0	7.8	7.8	0.0	7.7	7.7	0.0
Jun	6.0	6.0	0.0	6.0	6.0	0.0	6.0	6.0	0.0
Jul	5.8	5.8	0.0	5.8	5.8	0.0	5.7	5.8	0.0
Aug	5.8	5.9	0.0	5.8	5.9	0.0	5.8	5.8	0.0
Sep	5.7	5.7	0.0	5.7	5.7	0.0	5.6	5.7	0.0
Oct	6.3	6.3	0.0	6.2	6.3	0.0	6.2	6.3	0.0
Nov	6.6	6.6	0.0	6.6	6.6	0.0	6.6	6.6	0.0
Dec	7.2	7.3	0.0	7.2	7.2	0.0	7.2	7.2	0.0

CFR04 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.7	11.7	0.0	11.7	11.6	0.0	11.6	11.6	0.0
Feb	10.2	10.2	0.0	10.2	10.2	0.0	10.1	10.1	0.0
Mar	8.5	8.5	0.0	8.4	8.4	0.0	8.4	8.4	0.0
Apr	7.7	7.7	0.0	7.7	7.7	0.0	7.6	7.6	0.0
May	5.0	5.0	0.0	4.9	4.9	0.0	4.9	4.9	0.0
Jun	6.9	6.8	0.0	6.8	6.8	0.0	6.8	6.8	0.0
Jul	4.8	4.8	0.0	4.7	4.8	0.0	4.7	4.7	0.0
Aug	4.4	4.4	0.0	4.3	4.3	0.0	4.3	4.3	0.0
Sep	5.7	5.7	0.0	5.6	5.6	0.0	5.6	5.6	0.0
Oct	6.6	6.6	0.0	6.6	6.6	0.0	6.6	6.6	0.0
Nov	7.0	7.0	0.0	7.0	7.0	0.0	7.0	7.0	0.0
Dec	8.9	8.9	0.0	8.9	8.9	0.0	8.9	8.9	0.0

NECF03 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.3	11.3	0.0	11.3	11.3	0.0	11.3	11.3	0.0
Feb	10.0	10.0	0.0	10.0	10.0	0.0	10.0	10.0	0.0
Mar	8.9	9.0	0.0	8.9	8.9	0.0	8.9	8.9	0.0
Apr	9.0	9.0	0.0	9.0	9.0	0.0	8.9	9.0	0.0
May	7.6	7.6	0.0	7.5	7.5	0.0	7.5	7.5	0.0
Jun	6.1	6.1	0.0	6.0	6.1	0.0	6.0	6.0	0.0
Jul	6.1	6.1	0.0	6.1	6.1	0.0	6.0	6.1	0.0
Aug	6.3	6.3	0.0	6.3	6.3	0.0	6.3	6.3	0.0
Sep	6.6	6.6	0.0	6.5	6.5	0.0	6.5	6.5	0.0
Oct	7.6	7.6	0.0	7.5	7.5	0.0	7.5	7.5	0.0
Nov	8.3	8.3	0.0	8.3	8.3	0.0	8.3	8.3	0.0
Dec	8.4	8.5	0.0	8.4	8.4	0.0	8.4	8.4	0.0

CFR03 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.2	11.2	0.0	11.2	11.2	0.0	11.2	11.2	0.0
Feb	9.9	9.9	0.0	9.9	9.9	0.0	9.9	9.9	0.0
Mar	9.0	9.0	0.0	8.8	8.8	0.0	8.8	8.8	0.0
Apr	8.0	8.1	0.0	7.9	7.9	0.0	7.9	7.9	0.0
May	6.2	6.3	0.1	6.0	6.1	0.1	6.0	6.0	0.1
Jun	6.3	6.3	0.0	6.3	6.3	0.0	6.3	6.3	0.0
Jul	5.8	5.8	0.0	5.7	5.7	0.0	5.7	5.7	0.0
Aug	5.6	5.6	0.1	5.5	5.5	0.1	5.4	5.5	0.1
Sep	6.2	6.2	0.0	6.1	6.2	0.0	6.1	6.1	0.0
Oct	7.0	7.1	0.1	7.0	7.0	0.1	7.0	7.0	0.1
Nov	7.6	7.7	0.1	7.5	7.6	0.1	7.5	7.6	0.1
Dec	9.0	9.0	0.0	8.9	9.0	0.0	8.9	8.9	0.0

NECF02 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.3	11.2	-0.1	11.2	11.2	-0.1	11.2	11.1	-0.1
Feb	10.4	10.4	0.0	10.4	10.4	0.0	10.3	10.3	0.0
Mar	9.0	9.0	0.0	9.0	9.0	0.0	9.0	9.0	0.0
Apr	9.0	9.0	0.0	9.0	9.0	0.0	9.0	9.0	0.0
May	7.5	7.5	0.0	7.5	7.5	0.0	7.4	7.4	0.0
Jun	5.9	5.9	0.0	5.9	5.9	0.0	5.9	5.9	0.0
Jul	5.9	5.9	0.0	5.9	5.9	0.0	5.8	5.8	0.0
Aug	6.2	6.2	0.0	6.2	6.2	0.0	6.1	6.1	0.0
Sep	6.4	6.4	0.0	6.4	6.3	0.0	6.3	6.3	0.0
Oct	7.3	7.3	0.0	7.2	7.2	0.0	7.2	7.2	0.0
Nov	8.3	8.3	0.0	8.3	8.3	0.0	8.3	8.2	0.0
Dec	8.4	8.4	0.0	8.4	8.4	0.0	8.3	8.3	0.0

CFR02 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.3	11.3	0.0	11.3	11.3	0.0	11.2	11.2	0.0
Feb	9.8	9.8	0.0	9.8	9.8	0.0	9.8	9.8	0.0
Mar	8.7	8.7	0.0	8.6	8.7	0.0	8.6	8.6	0.0
Apr	7.9	7.9	0.0	7.8	7.8	0.0	7.8	7.8	0.0
May	6.3	6.4	0.1	6.3	6.3	0.1	6.2	6.3	0.1
Jun	6.1	6.1	0.0	6.1	6.1	0.0	6.1	6.1	0.0
Jul	5.8	5.9	0.0	5.8	5.8	0.0	5.8	5.8	0.0
Aug	5.7	5.7	0.1	5.6	5.7	0.1	5.6	5.7	0.1
Sep	6.3	6.3	0.0	6.2	6.3	0.0	6.2	6.2	0.0
Oct	7.2	7.2	0.0	7.2	7.2	0.0	7.1	7.2	0.0
Nov	7.7	7.7	0.1	7.6	7.7	0.1	7.6	7.7	0.1
Dec	8.8	8.9	0.0	8.8	8.8	0.0	8.8	8.8	0.0

CFR01 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	11.0	10.9	0.0	10.8	10.7	-0.1	10.7	10.6	-0.1
Feb	9.7	9.7	0.0	9.7	9.7	0.0	9.7	9.6	0.0
Mar	8.5	8.6	0.0	8.5	8.4	0.0	8.4	8.4	0.0
Apr	7.9	7.9	0.0	7.8	7.8	0.0	7.8	7.8	0.0
May	6.7	6.8	0.0	6.7	6.7	0.0	6.7	6.7	0.0
Jun	5.8	5.8	0.0	5.7	5.7	0.0	5.6	5.6	0.0
Jul	5.7	5.7	0.0	5.6	5.6	0.0	5.5	5.5	0.0
Aug	5.7	5.7	0.0	5.6	5.7	0.0	5.6	5.6	0.0
Sep	6.1	6.1	0.0	6.0	6.0	0.0	6.0	6.0	0.0
Oct	7.0	7.0	0.0	6.8	6.8	0.0	6.8	6.8	0.0
Nov	7.7	7.7	0.0	7.6	7.6	0.0	7.6	7.6	0.0
Dec	8.5	8.5	0.0	8.4	8.3	0.0	8.3	8.3	0.0

NECF01 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.7	10.6	-0.1	10.5	10.4	-0.1	10.5	10.4	-0.1
Feb	10.3	10.2	-0.1	10.2	10.1	-0.1	10.1	10.0	-0.1
Mar	8.8	8.8	-0.1	8.7	8.6	-0.1	8.6	8.5	-0.1
Apr	8.8	8.7	-0.1	8.6	8.5	-0.1	8.5	8.4	-0.1
May	7.5	7.4	-0.1	7.3	7.2	-0.1	7.2	7.1	-0.1
Jun	5.8	5.7	0.0	5.7	5.6	0.0	5.6	5.6	0.0
Jul	5.7	5.7	0.0	5.6	5.6	0.0	5.6	5.6	0.0
Aug	5.9	5.9	0.0	5.9	5.8	0.0	5.8	5.8	0.0
Sep	6.1	6.1	0.0	6.1	6.0	0.0	6.0	6.0	0.0
Oct	6.9	6.9	-0.1	6.8	6.8	-0.1	6.8	6.7	-0.1
Nov	8.0	8.0	-0.1	7.9	7.8	-0.1	7.9	7.8	-0.1
Dec	8.2	8.1	-0.1	8.1	8.0	-0.1	8.0	8.0	-0.1

Battleship — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.4	10.3	-0.1	10.1	10.0	-0.2	9.9	9.8	-0.2
Feb	9.9	9.8	-0.1	9.8	9.6	-0.1	9.6	9.5	-0.2
Mar	8.5	8.5	-0.1	8.3	8.2	-0.1	8.2	8.1	-0.1
Apr	8.2	8.2	-0.1	8.1	8.0	-0.1	8.0	7.8	-0.2
May	7.2	7.1	-0.1	7.0	6.9	-0.2	6.9	6.7	-0.2
Jun	5.7	5.6	-0.1	5.5	5.5	-0.1	5.5	5.4	-0.1
Jul	5.6	5.5	0.0	5.5	5.4	0.0	5.4	5.4	-0.1
Aug	5.7	5.7	0.0	5.6	5.6	-0.1	5.6	5.5	-0.1
Sep	6.0	5.9	0.0	5.8	5.8	-0.1	5.8	5.7	-0.1
Oct	6.7	6.7	-0.1	6.6	6.5	-0.1	6.5	6.4	-0.1
Nov	7.7	7.6	-0.1	7.6	7.5	-0.1	7.5	7.4	-0.1
Dec	8.1	8.0	-0.1	7.8	7.7	-0.1	7.7	7.6	-0.1

LowerAnchorageBasin — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	10.4	10.2	-0.1	9.9	9.7	-0.2	9.5	9.4	-0.1
Feb	10.0	9.9	-0.1	9.6	9.4	-0.2	9.3	9.3	0.0
Mar	8.6	8.5	-0.1	8.2	8.1	-0.1	8.0	8.0	0.0
Apr	8.4	8.3	-0.1	7.9	7.8	-0.2	7.6	7.6	-0.1
May	7.4	7.2	-0.2	7.0	6.8	-0.2	6.7	6.6	-0.1
Jun	5.7	5.6	-0.1	5.5	5.4	-0.1	5.4	5.4	0.0
Jul	5.6	5.5	-0.1	5.5	5.4	-0.1	5.3	5.4	0.0
Aug	5.7	5.7	0.0	5.6	5.5	-0.1	5.4	5.5	0.0
Sep	6.0	5.9	-0.1	5.8	5.7	-0.1	5.6	5.6	0.0
Oct	6.7	6.7	-0.1	6.5	6.4	-0.1	6.4	6.4	0.0
Nov	7.7	7.6	-0.1	7.4	7.3	-0.1	7.2	7.2	0.0
Dec	8.0	7.9	-0.1	7.7	7.5	-0.1	7.4	7.4	0.0

LowerBigIsland — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.9	9.8	-0.1	9.6	9.4	-0.1	9.5	9.3	-0.2
Feb	10.0	9.9	-0.1	9.6	9.5	-0.2	9.6	9.4	-0.2
Mar	8.7	8.7	-0.1	8.5	8.4	-0.1	8.4	8.3	-0.1
Apr	8.5	8.4	-0.1	8.1	8.0	-0.2	8.1	7.9	-0.2
May	7.5	7.4	-0.1	7.2	7.0	-0.2	7.1	6.9	-0.2
Jun	5.9	5.9	-0.1	5.8	5.7	-0.1	5.8	5.7	-0.1
Jul	5.7	5.7	-0.1	5.7	5.6	-0.1	5.6	5.6	-0.1
Aug	5.8	5.7	-0.1	5.7	5.6	-0.1	5.7	5.6	-0.1
Sep	6.0	5.9	-0.1	5.9	5.8	-0.1	5.9	5.8	-0.1
Oct	6.7	6.6	-0.1	6.6	6.5	-0.1	6.6	6.5	-0.1
Nov	7.7	7.6	-0.1	7.5	7.4	-0.1	7.4	7.3	-0.1
Dec	7.9	7.9	-0.1	7.7	7.6	-0.1	7.7	7.5	-0.1

LowerLilliput — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.6	9.5	-0.1	9.3	9.1	-0.1	9.2	9.1	-0.1
Feb	9.9	9.8	-0.1	9.5	9.4	-0.1	9.4	9.3	-0.1
Mar	8.9	8.8	-0.1	8.6	8.5	-0.1	8.5	8.4	-0.1
Apr	8.6	8.5	-0.1	8.1	8.0	-0.1	8.1	7.9	-0.1
May	7.5	7.4	-0.1	7.1	7.0	-0.1	7.1	7.0	-0.1
Jun	6.1	6.0	-0.1	6.0	5.9	-0.1	5.9	5.9	-0.1
Jul	5.8	5.8	-0.1	5.8	5.7	-0.1	5.7	5.7	-0.1
Aug	5.9	5.8	-0.1	5.7	5.7	-0.1	5.7	5.6	-0.1
Sep	6.0	6.0	-0.1	5.9	5.8	-0.1	5.9	5.8	-0.1
Oct	6.7	6.6	-0.1	6.6	6.5	-0.1	6.5	6.5	-0.1
Nov	7.6	7.5	-0.1	7.4	7.3	-0.1	7.3	7.2	-0.1
Dec	7.9	7.9	-0.1	7.7	7.6	-0.1	7.7	7.6	-0.1

LowerMidnight — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	9.2	9.1	-0.1	8.9	8.8	-0.1	8.8	8.8	-0.1
Feb	9.6	9.6	-0.1	9.2	9.2	-0.1	9.1	9.1	-0.1
Mar	8.8	8.8	-0.1	8.5	8.5	-0.1	8.5	8.4	-0.1
Apr	8.4	8.3	-0.1	8.0	7.9	-0.1	7.9	7.8	-0.1
May	7.3	7.2	-0.1	7.0	6.9	-0.1	6.9	6.8	-0.1
Jun	6.1	6.1	-0.1	6.0	6.0	-0.1	6.0	5.9	-0.1
Jul	5.9	5.8	-0.1	5.7	5.7	-0.1	5.7	5.7	-0.1
Aug	5.8	5.7	-0.1	5.6	5.6	-0.1	5.6	5.5	-0.1
Sep	6.0	5.9	-0.1	5.8	5.7	-0.1	5.7	5.7	-0.1
Oct	6.6	6.5	-0.1	6.4	6.4	-0.1	6.4	6.3	-0.1
Nov	7.5	7.4	-0.1	7.2	7.1	-0.1	7.1	7.0	-0.1
Dec	7.8	7.7	-0.1	7.6	7.5	-0.1	7.5	7.4	-0.1

SnowMarsh — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.8	8.7	-0.1	8.5	8.5	0.0	8.5	8.4	-0.1
Feb	9.2	9.2	-0.1	8.9	8.8	0.0	8.8	8.7	0.0
Mar	8.6	8.6	-0.1	8.3	8.3	-0.1	8.3	8.2	-0.1
Apr	8.1	8.0	-0.1	7.7	7.7	-0.1	7.6	7.6	-0.1
May	7.0	7.0	-0.1	6.7	6.7	-0.1	6.7	6.6	-0.1
Jun	6.1	6.0	0.0	5.9	5.9	0.0	5.9	5.8	0.0
Jul	5.7	5.7	0.0	5.6	5.5	0.0	5.6	5.5	0.0
Aug	5.6	5.6	-0.1	5.4	5.4	0.0	5.4	5.3	-0.1
Sep	5.7	5.7	-0.1	5.5	5.5	-0.1	5.5	5.4	-0.1
Oct	6.4	6.3	-0.1	6.2	6.1	-0.1	6.1	6.1	-0.1
Nov	7.1	7.0	-0.1	6.8	6.8	-0.1	6.8	6.7	-0.1
Dec	7.6	7.5	-0.1	7.3	7.2	-0.1	7.2	7.2	-0.1

BatteryIsland — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			**Middle**			**Bottom**		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.5	8.5	0.0	8.4	8.3	0.0	8.3	8.3	0.0
Feb	8.9	8.9	0.0	8.7	8.7	0.0	8.6	8.6	0.0
Mar	8.5	8.4	-0.1	8.2	8.2	0.0	8.1	8.1	-0.1
Apr	7.9	7.9	-0.1	7.5	7.5	-0.1	7.4	7.4	-0.1
May	6.9	6.8	-0.1	6.6	6.5	0.0	6.4	6.4	-0.1
Jun	6.0	6.0	0.0	5.8	5.8	0.0	5.8	5.7	0.0
Jul	5.6	5.6	0.0	5.5	5.5	0.0	5.4	5.4	0.0
Aug	5.4	5.4	-0.1	5.3	5.2	0.0	5.2	5.1	0.0
Sep	5.5	5.5	-0.1	5.4	5.3	0.0	5.3	5.2	0.0
Oct	6.2	6.1	-0.1	6.0	6.0	-0.1	6.0	5.9	-0.1
Nov	6.9	6.8	-0.1	6.7	6.6	-0.1	6.6	6.5	-0.1
Dec	7.4	7.3	-0.1	7.1	7.1	0.0	7.0	7.0	-0.1

BaldheadShoalR1 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	8.1	8.2	0.0	8.0	8.0	0.0	7.9	7.9	0.0
Feb	8.6	8.6	0.0	8.3	8.3	0.0	8.2	8.3	0.1
Mar	8.1	8.1	0.0	7.8	7.8	0.0	7.7	7.7	0.0
Apr	7.5	7.5	0.0	7.0	7.0	0.0	6.8	6.8	0.0
May	6.3	6.3	0.0	6.0	5.9	0.0	5.8	5.9	0.0
Jun	5.7	5.7	0.0	5.4	5.4	0.0	5.4	5.4	0.0
Jul	5.3	5.3	0.0	5.1	5.1	0.0	5.0	5.1	0.0
Aug	5.0	5.0	0.0	4.8	4.8	0.0	4.7	4.7	0.0
Sep	5.1	5.1	0.0	4.9	4.9	0.0	4.8	4.8	0.0
Oct	5.8	5.8	0.0	5.6	5.6	0.0	5.5	5.5	0.0
Nov	6.4	6.4	0.0	6.2	6.1	0.0	6.0	6.1	0.0
Dec	7.0	7.0	0.0	6.7	6.7	0.0	6.6	6.6	0.0

BaldheadShoalR3 — Dissolved Oxygen (mg/L) Comparison for Dry Year

	Surface			Middle			Bottom		
Month	FwoP	FwP	Δ	FwoP	FwP	Δ	FwoP	FwP	Δ
Jan	7.8	7.8	0.0	7.1	7.2	0.1	7.0	7.0	0.0
Feb	8.2	8.2	0.0	7.4	7.5	0.1	7.3	7.4	0.1
Mar	7.8	7.8	0.0	6.8	6.9	0.0	6.8	6.8	0.0
Apr	7.0	6.9	-0.1	5.0	5.0	0.0	4.8	4.8	0.0
May	5.8	5.7	-0.1	4.1	4.2	0.1	3.9	3.9	0.0
Jun	5.3	5.3	0.0	4.3	4.4	0.1	4.1	4.1	0.0
Jul	5.0	5.0	0.0	4.2	4.3	0.1	4.0	4.1	0.1
Aug	4.6	4.6	0.0	3.7	3.8	0.1	3.5	3.6	0.0
Sep	4.7	4.6	0.0	3.8	3.8	0.1	3.6	3.6	0.0
Oct	5.4	5.4	0.0	4.6	4.6	0.0	4.4	4.4	0.0
Nov	5.9	5.9	-0.1	5.0	4.9	0.0	4.8	4.8	0.0
Dec	6.5	6.4	0.0	5.6	5.6	0.0	5.5	5.4	0.0

Appendix E–1: Well Completion Report and Site Conceptual Model

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REVISED
WELL COMPLETION REPORT AND SITE CONCEPTUAL MODEL
PORT OF WILMINGTON
SECTION 203
NAVIGATION CHANNEL IMPROVEMENT
GMA PROJECT #160001

Prepared for

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1.0 Introduction

The Port of Wilmington is working to improve the Navigation Channel leading to the port. The improvements will entail widening and deepening of the shipping channel to accommodate larger ships in the port. Groundwater Management Associates, Inc. (GMA) was contracted by Moffatt & Nichol to provide a hydrogeologic evaluation of the potential for saltwater intrusion as a result of the proposed navigation channel improvements. GMA's study includes two phases of work: 1) supplemental groundwater data collection and site conceptual model development, and 2) groundwater computer modeling. This report presents a summary of the completion of phase 1 of the project.

2.0 Background

The North Carolina State Ports Authority (NCSPA) desires to modify the channel to the Port of Wilmington to facilitate improved shipping into the State. The proposed improvements consist primarily of widening and deepening of the shipping channel (Figure 1). Of particular interest is whether or not the channel modifications would result in saltwater intrusion as a consequence removing fine-grained sediments that may occur directly beneath the channel.

In 1998, the North Carolina Department of Environment, Health, and Natural Resources, Division of Water Resources (NCDWR) developed a hydrogeologic assessment and groundwater model of the proposed deepening of the Wilmington Harbor shipping channel (Lautier, 1998). Lautier's study was performed to support decisions on previous channel improvements. Lautier's groundwater flow model employed the FEMWATER program, a three-dimensional finite element groundwater flow model developed by the U.S. Army Waterways Experiment Station-Hydraulics Lab (Yeh, 1987). NCDWR used the preprocessor/postprocessor called Groundwater Modeling System (GMS) to facilitate construction and operation of the groundwater flow model. The model included a 3-d finite element mesh.

The basis of the NCDWR model grid and input parameters was a Hydrogeologic Framework Study performed by NCDWR that encompassed Brunswick and New Hanover counties. The framework study provided details of hydrostratigraphy, aquifer hydraulic properties, and hydraulic head for the primary aquifer units that occur in the region (Lautier, 1998). The calibrated groundwater flow model was then used to perform simulations of groundwater conditions following the proposed deepening of the channel by 5 feet. The NCDWR groundwater model demonstrated that the aquifer system maintained a discharge relationship to the Cape Fear River and the shipping channel, both before and after simulated deepening of the channel by 5 feet. Under this relationship, fresh groundwater from the adjacent aquifer system flows toward, and discharges to, the more saline Cape Fear River, and not vice versa. In other words, the NCDWR model indicated that deepening of the channel was not expected to induce saltwater intrusion into the adjacent and underlying aquifers.

The channel was deepened after completion of the NCDWR study, and the "…current dredging activities maintain the channel to at least an elevation (El.) of -42 feet (referenced to mean lower low water [MLLW]) with an overdredge allowance of 2 feet from Anchorage Basin to Lower Swash and El. -44 feet (MLLW) with an overdredge allowance of 2 feet from Battery Island to Baldhead Shoal Reach 3" (Fugro, 2018). Future channel improvements planned by the NCSPA may include deepening, widening, and/or realigning the existing navigation channel (Fugro, 2018).

GMA was contracted to provide updated groundwater modeling of the area to evaluate the possible effects of the proposed channel improvements. Because the previous modeling performed by NCDWR was suitable for evaluation of the previous channel improvements, GMA's modeling will incorporate the NCDWR groundwater model as a starting point, and we will update and recalibrate the model by incorporating new data. We will then integrate the proposed channel modifications and run groundwater flow simulations to evaluate the impacts of the proposed channel modifications.

3.0 Hydrogeologic Setting

The Port of Wilmington lies on the lower reach of the Cape Fear River in the Coastal Plain of North Carolina (Figure 2). The Cape Fear River is the dividing line between eastern Brunswick County, lying on the western shore of the river, and southern New Hanover County, lying to the east of the river. North Carolina's Coastal Plain is a broad, nearly flat physiographic province separating the hilly Piedmont province from the Atlantic Ocean (Figure 2). Coastal Plain topography and subsurface geology have been shaped throughout the Mesozoic and Cenozoic eras by numerous, and occasionally large, fluctuations in sea level that caused repeated lateral transgressions and regressions of the Atlantic shoreline. The Coastal Plain is a region of near-shore deposition of sediments along a passive continental margin that formed as eastern North America eroded slowly following the opening of the Atlantic Ocean in the Jurassic (Olsen, et al., 1991). In broad perspective, these deposits form a sedimentary wedge that thickens seaward (Figure 3). Sediment accumulations in the North Carolina Coastal Plain are thicker to the north and east of New Hanover County within a down-warped basin known as the Albemarle Embayment. New Hanover County lies atop a structural high where the crystalline basement rocks are much shallower because they have been up-warped to form the Cape Fear Arch (Harris and Zullo, 1991) (Figure 4).

Coastal Plain sediments and sedimentary rocks comprise the aquifer systems that are the sources of water supply within southern New Hanover and eastern Brunswick Counties. The composition of these geologic deposits reflects ancient coastal environments over the past 90 million years (Ma). Geologists have described and mapped these deposits (e.g., NCGS, 1985), and they have subdivided the strata into various geologic formations and groups (Table 1) based upon their age and composition (lithology). In order to understand the groundwater resources in southern New Hanover and eastern Brunswick Counties, we must first understand the ages and lithologies of the Coastal Plain sediments and rocks that comprise the aquifer systems. The following sections present a systematic summary of the hydrogeologic setting of New Hanover County and the eastern portion of Brunswick County.

3.1 TOPOGRAPHY AND GEOMORPHOLOGY

Land surface topography in southern New Hanover and eastern Brunswick Counties (Figure 5) is primarily a product of Neogene and Quaternary fluctuations in sea level that repeatedly inundated and exposed the land over the past 23 million years (Horton and Zullo, 1991). These sea-level cycles sculpted the land surface into relatively flat marine terraces bounded by low escarpments that represent former shorelines. Recent incision of the land by surface water features (chiefly the Cape Fear River, the Northeast Cape Fear River, and their tributaries) has dissected the marine terraces and locally exposed older marine deposits.

Much of the topography of New Hanover County is a function of the occurrence of limestone and sandstone deposits of the Castle Hayne and Peedee Formations, respectively. These consolidated rocks are relatively resistant to weathering, and they have produced a high-ground in the middle to western portion of New Hanover County, with elevations of up to 65+ feet occurring in parts of Wilmington. This platform of resistant rock presents a barrier to eastward migration of the channels of the Northeast Cape Fear River and the Cape Fear River, and the river system follows a southerly route as it skirts the western edge of these more resistant rocks. Bain (1970) mapped the elevations of the top of indurated rocks in New Hanover County, and areas where indurated limestone of the Castle Hayne Formation or sandstone of the Peedee Formation attain average elevations above mean sea level generally correspond to areas with elevated topography.

In Brunswick County, the land elevation adjacent to the Cape Fear River is much lower (commonly less than 30 feet elevation) than the eastern side of the river. Much of the shallow sediments beneath Brunswick County are unconsolidated clays and sands, with occasional outliers of limestone and sandstone of the Castle Hayne and Peedee Formations (Harden, et al., 2003). In southern Brunswick County near Southport, indurated limestone of the Castle Hayne Formation becomes prominent again in the shallow subsurface, and land elevations of up to 60 feet occur in this area as a result of the more resistant shallow rocks in those areas. Figure 6 illustrates the general occurrences of the indurated sedimentary rocks of the Castle Hayne and Peedee Formations in New Hanover and Brunswick Counties at elevations above -10 feet MSL. These indurated sedimentary rocks subcrop beneath portions of the Cape Fear River, and in some areas these rocks will likely be encountered during channel improvements (Fugro, 2018).

3.2 AQUIFER UNITS

Beneath the modern land surface is a complex sequence of marine, estuarine, and terrestrial sediments and sedimentary rocks that are the framework of the groundwater system in southern New Hanover and eastern Brunswick Counties (Figure 7). These deposits range from approximately 1000 feet thick in northern Brunswick County to more than 1500 feet thick near Bald Head Island (Lawrence and Hoffman, 1993), and they lie unconformably above the pre-Mesozoic crystalline basement rocks. The groundwater system beneath southern New Hanover and eastern Brunswick Counties includes distinctive sequences of permeable sediments and sedimentary rocks (aquifers) that are capable of producing usable quantities of water to wells. The aquifers are separated by strata with low permeability that restrict the vertical movement of groundwater between aquifers. These low permeability units are termed confining layers (Heath, 1983) (Figure 8).

The hydrostratigraphic units that comprise the aquifers and confining layers beneath southern New Hanover and eastern Brunswick Counties are summarized in Table 1. These aquifer names are consistent with hydrostratigraphic nomenclature used by NCDWR (Lautier, 1998) and the United States Geological Survey (USGS) (Winner and Coble, 1996). The confining layers separating aquifers in southern New Hanover and eastern Brunswick Counties vary in their ability to restrict inter-aquifer flow. Very low permeability units are often comprised of clay, and thick sequences of clay (e.g., the Black Creek Confining Layer) separate fully-confined aquifers. In contrast, some confining layers are comprised of low- to moderate-permeability sediments (e.g., silty sand) that cannot yield significant quantities of water to pumping wells, yet these sediments still allow significant vertical movement of water between aquifers. In southern New Hanover and eastern Brunswick Counties, these leaky or "semi-confining" layers typically occur between Cenozoic-age aquifers (e.g., the Castle Hayne Confining Layer).

Because Lautier performed a comprehensive framework study of the aquifers and confining units that are, or may be, hydraulically connected to the Cape Fear River channel in the region, GMA has accepted Lautier's hydrostratigraphic framework as the foundation of our groundwater flow modeling. However, new wells have been drilled in the region, and groundwater use has expanded in some areas since Lautier's study of 1998. Therefore, GMA's model is being refined to include these updated data.

3.3 EXPANDED GROUNDWATER UTILIZATION

Since Lautier's hydrogeological assessment and groundwater modeling study (1998), there have been significant expansions in groundwater utilization in the region. The more significant expansions include:

- New Hanover County/Cape Fear Public Utility Authority (CFPUA) constructed the New Hanover County Wellfield in 2008 (Figure 9). The wellfield is located west of Highway 17 from Ogden Park to Interstate I140 (GMA, 2014). The wellfield consists of 15 wells with paired Castle Hayne Aquifer and Peedee Aquifer wells at many of the well sites. Details of well construction and operation are known, and these details will be incorporated into the updated groundwater flow model. As of 2016, CFPUA operates 39 wells with a combined 12-hour supply of 11.264 million gallons per day (MGD) (Local Water-Supply Plan 2016).
- The Town of Carolina Beach has added 3 new wells to their system (Figure 9). The wellfield expansion included wells in proximity to the Cape Fear River. Some of the wells located closer to the river bank have exhibited evidence of saltwater intrusion in response to local depressurization of the Peedee Aquifer. As of 2016, the combined 12-hour supply of the Carolina Beach well system was 2.012 MGD, which is 1.123 MGD higher than in 1997.
- CFPUA added an Aquifer Storage Recovery (ASR) well located on Westbrook Road in Wilmington (Figure 9). This site included a deep core hole to 650 feet depth, geophysical logs, test well construction, and ASR production well installation (GMA, 2006, GMA, 2012). Data on the aquifer hydraulic properties of the Peedee and Black Creek Aquifers were obtained from the site. These new data will be incorporated into the updated groundwater flow model.
- The Brunswick County Castle Hayne Aquifer Wellfield near Southport (Figure 9) has expanded to a combined 12-hour supply of approximately 8.88 MGD. This is a 1.5 MGD expansion since the late 1990's.
- Archer Daniels Midland Company (ADM) and Duke Energy Brunswick Nuclear Plant (BNP) facilities near Southport (Figure 9) have constructed new wellfields that withdraw from the Peedee Aquifer. Withdrawals from these wellfields resulted in observable drawdown in the Peedee Aquifer by 2005. The cone of depression associated with these wellfields has locally lowered groundwater levels by more than 35 feet. The cone of

depression in the Peedee Aquifer has expanded to the southeast, and head in the Peedee Aquifer adjacent to the river along Shepard Road averages approximately 5 feet *below* mean sea level.

- The Brunswick Regional Water and Sewer H2GO (H2GO) has embarked on the development of a new wellfield near Leland (Figure 9). The wellfield will be supplied by paired wells withdrawing brackish water from the lower Peedee and Black Creek Aquifers. The combined capacity of the initial wellfield will be 5.4 MGD. Drilling and aquifer test data from the wellfield construction will be used to refine the groundwater model (GMA, April 11, 2016). In addition, H2GO has drilled a 650 feet depth continuous wire-line core hole as a part of an ASR feasibility study (GMA, April 30, 2015) (Figure 9). The core-hole data provide important hydrostratigraphic references for refining the groundwater model framework.

4.0 Monitoring Well Construction and Data Collection

GMA recognized that there have been significant increases in groundwater utilization in the vicinity of the proposed Port of Wilmington Section 203 Navigation Channel Improvements since the last groundwater modeling effort was completed (Lautier, 1998). The existing monitoring well network maintained by the United States Geological Survey and the NC Division of Water Resources lacks data sources in areas that may be affected by the new groundwater withdrawals. Therefore, GMA constructed three new monitoring well stations to provide critical data to support updating the groundwater model of the area. Data obtained from the monitoring well stations included groundwater elevations, data on tidal interconnection between the Cape Fear River and the aquifers, hydraulic properties of the aquifer units, and water quality data. These monitoring stations provide baseline information at important locations along the proposed channel modifications. These stations can also be monitored after the channel improvements have been completed to evaluate whether the groundwater system in these areas conforms to the predictions of the groundwater modeling.

4.1 SITE SELECTION

Three critical areas were selected for installation of monitoring wells (Figure 10). Site #1 is on Front Street in Wilmington, and it was selected for its proximity to the Wilmington Port. The site location was also important because it is west of the new CFPUA wellfield near Ogden Park. Site #1 was placed on property owned by the Wilmington Port Authority at the former Southern Wood Piedmont Company facility near the intersection of Front Street and Greenfield Street (Figure 11). The former Southern Wood Piedmont site was a wood treatment facility, and the site has an ongoing assessment and cleanup program being conducted by Schnabel Engineering for wood treatment contaminants in the groundwater beneath the site. The NC State Ports Authority selected a location along the norther border of the property for GMA to construct the monitoring wells. The site selected was outside of the known groundwater contaminant plume area.

Site #2 was placed at the NCDOT Ferry Terminal near Fort Fisher (Figure 10). This station was selected to provide data on water levels and water quality in proximity to the expanded groundwater withdrawals at Carolina Beach. The original plan was to construct the monitoring wells to the west of the Carolina Beach wellfield close to the Cape Fear River. This is an area with known saltwater intrusion resulting from groundwater withdrawals in close proximity to the Cape Fear River. However, the area west of the Carolina Beach wellfield is part of the Military Ocean Terminal Sunny Point exclusion zone. Attempts to gain access to the exclusion zone for monitoring well construction were unsuccessful, so the Fort Fisher Ferry Terminal site was selected as the closest option to gain more data from that general area (Figure 12).

Site #3 is located on the western bank of the Cape Fear River near Southport (Figure 10). This site was selected to provide hydrostratigraphy, water level, and water quality data between the river and the wellfields of the Archer Daniels Midlands site, the Duke Energy facility, and the Castle Hayne Aquifer wellfield at Southport. Site #3 is on property owned by the NC State Ports Authority on Shepard Road (Figure 13).

The NC State Ports Authority provided assistance with obtaining access to each of the sites. GMA acquired well construction permits for monitoring well installation, and copies of well permits are included in Appendix I.

4.2 WELL DRILLING AND INSTALLATION

GMA developed a drilling specification document for the monitoring wells to be installed at each site. We contracted Skippers Well Drilling and Pump Service (Skippers) to construct wells at Site #1 (Front Street – Wilmington) and Site #3 (Southport) (Figures 11 and 13, respectively). Magette Well and Pump Company was contracted to install wells at Site #2 (Fort Fisher Ferry) (Figure 12). Each site included three wells, a shallow Surficial Aquifer well, an intermediate depth well screened in the Castle Hayne Aquifer or its stratigraphic equivalent, and a deeper well open to the Peedee Aquifer. Wells were installed with mud-rotary drilling methods. Due to lost circulation conditions in the Peedee Aquifer at Site #1, direct air-rotary drilling was used complete the Peedee Aquifer well.

A GMA geologist was present during the pilot hole drilling at each site to document drilling conditions, collect and describe samples of drill cuttings, and select appropriate screen depths for individual wells to be constructed. Upon completion of the pilot hole, the drilling contractor performed a geophysical log (Natural Gamma, SP, Single-Point Resistance, and Normal Resistivity) of the pilot hole. GMA interpreted the geophysical log and selected final screen placements for the monitoring wells at each site. Monitoring wells were equipped with locking above ground well covers, and the well heads were protected by bollards (See Appendix II). Table 2 lists the details of well construction at each station. Well construction records, drilling logs, geophysical logs, and site photographs are included in Appendix II.

4.3 AQUIFER TESTING

The new monitoring well network provided the opportunity to further characterize the hydraulic properties of the Surficial, Castle Hayne, and Peedee Aquifers to support model refinement. GMA conducted two types of aquifer tests: slug tests and constant rate pumping tests. Slug tests were performed on surficial aquifer monitoring wells at each site. Slug testing involved lowering a stainless steel cylinder of known volume (a slug) into each well to induce an instantaneous rise in water level as water is displaced by the slug (a slug-in test). Water levels are monitored continuously until the induced water level change recovers to static conditions. A slug-out test is then performed by withdrawing the slug from the well and monitoring the water level rise until static water level conditions return. GMA deployed a pressure transducer/data logger in each well to monitor water levels during the slug in and slug out tests. The rate of water-level recovery from the slug tests was analyzed using the Hvorslev (1951) and Bouwer-Rice (1976) methods to estimate the hydraulic conductivity of the screened portion of the aquifer at each well tested. Slug testing is a common method of estimating hydraulic conductivity on low permeability aquifer materials or for very shallow wells with limited available drawdown.

Each of the deeper wells was tested via pumping at a constant rate for a short-duration of pumping. Pumping duration was 6 hours for the Castle Hayne and Peedee Aquifer wells at Site #2 (Fort Fisher Ferry) and Site #3 (Southport). GMA monitored the static and pumping water levels during each constant-rate pumping test, and we analyzed the drawdown data using the Cooper-Jacob (1946) and Theis Recovery (Theis, 1935) methods. These tests provided estimates of aquifer transmissivity for the screened aquifer at each well tested. Knowing aquifer thickness, the transmissivity values were converted to hydraulic conductivity using the formula $T = K/b$, where T = transmissivity, K = hydraulic conductivity, and b = aquifer thickness.

Testing of the Fluvial Aquifer well and the Peedee Aquifer well at Site #1 (Front Street – Wilmington) was limited to three hours of step-drawdown testing due to concerns over the quality of water produced by the wells. Site #1 exhibited a prominent petroleum odor in water pumped from the Fluvial Aquifer and Peedee Aquifer wells. GMA was concerned about discharging large volumes of water contaminated by petroleum hydrocarbons at the site. GMA is aware of an ongoing groundwater assessments at the Southern Wood Piedmont and the Buckeye Terminal facilities to the south and north, respectively, of the monitoring well station. GMA believes that the petroleum odor was likely associated with the Buckeye Terminal bulk fuel storage facility located immediately north of the monitoring wells at Site #1 (NCDEQ Groundwater Incident #32293). The drilling contractor (Skippers) performed step-drawdown tests (preliminary pumping tests) in preparation for planned 6-hour constant rate pumping tests. The step-drawdown testing involved pumping at three progressively increasing flow rates of one hour duration per step. Flow rates for the two step-drawdown tests were 25, 35, and 52 gpm. Skippers monitored the flow rates and pumping water levels during the two step-drawdown tests, and Skippers provided the data to GMA for analysis. Although the step-drawdown tests are less reliable for estimating hydraulic conductivity than constant-rate pumping tests, GMA decided to not perform the 6-hour constant-rate pumping tests on the two deeper wells at Site #1 due to concerns that water produced by the wells likely contained petroleum contamination. GMA analyzed the step-drawdown test data using the Theis (1938) and Cooper-Jacob (1946) methods. Results of all aquifer testing are summarized in Table 3. Appendix III includes copies of all aquifer test data and analyses.

4.4 WATER-QUALITY SAMPLING

Upon completion and development, each monitoring well was sampled for chemical analysis. Because the intent of the monitoring wells was to evaluate potential saltwater intrusion areas, the laboratory analyses of water samples from the well were limited to chloride and total dissolved solids (TDS). The Surficial Aquifer wells at all three sites and the Fluvial Aquifer and Peedee Aquifer wells from Site #1 (Front Street) were sampled using a low-flow purge pump. GMA calculated the volume of water column in each well, and we purged a minimum of three well volumes of water prior to sample collection. The purge pumping rate ranged from 2 to 3 gallons per minute. For the Castle Hayne and Peedee Aquifer monitoring wells at Site #2 and Site #3, GMA collected water samples near the end of the 6-hour constant rate pumping tests. All water samples were placed in laboratory supplied containers and were delivered to Environmental Chemists of Wilmington for certified analyses. Results of the laboratory analyses are presented in Table 4. Appendix IV includes copies of the laboratory results.

The Surficial Aquifer at Site #1 (Front Street) (Figure 11) was brackish. The Surficial Aquifer at Site #1 is hydraulically connected to the Cape Fear River. The monitoring well locations at Site #1 are within the margin of a marsh, and marsh grasses and fiddler crabs were evident adjacent to the monitoring wells. As tides fluctuated in the Cape Fear River adjacent to Site #1, the water table would locally breach the land surface causing local tidal pools in the marsh. Considering the proximity of tidally influenced marshlands near the monitoring wells at Site #1, it is not surprising that the Surficial Aquifer contains brackish water. The Fluvial Aquifer and Peedee Aquifer monitoring wells at Site #1 both contained fresh groundwater. This indicates that these semi-confined to confined aquifers are not locally experiencing saltwater intrusion at Site #1.

Site #2 (Fort Fisher Ferry) (Figure 12) exhibited brackish groundwater conditions in all three aquifers screened at the site. The Surficial Aquifer monitoring well is located only 250 feet away from the highly brackish Cape Fear River. The monitoring well area is only about 9 feet above sea level, and this area is prone to periodic storm surge inundation. Therefore, the presence of slightly brackish groundwater in the Surficial Aquifer well is not surprising. The Castle Hayne Aquifer at Site #2 is very brackish, with salinity being approximately 2/3 that of ocean water salinity. The Castle Hayne Aquifer at the Fort Fisher Ferry site is semi-confined. The top of the Castle Hayne Aquifer occurs at an elevation of approximately -30 feet MSL, and the semi-confining layer above the aquifer is only about 10 feet thick. The Castle Hayne semi-confining layer is likely absent within a mile off-shore. Also, the confining layer is likely absent beneath the existing shipping channel of the Cape Fear River approximately 0.5 miles to the west, so the Castle Hayne Aquifer at the Fort Fisher Ferry site is already affected by saltwater intrusion. The Peedee Aquifer at Site #2 contains moderately brackish groundwater consistent with regional mapping of naturally occurring brackish groundwater in the area.

Site #3 (Southport) (Figure 13) demonstrates fresh groundwater conditions in the Surficial, Castle Hayne, and Peedee Aquifers. The Surficial Aquifer does, however, exhibit elevated Total Dissolved Solids that is not associated with saltwater. The chloride concentration of the Surficial Aquifer is only 14 mg/L. However, the TDS is >2000 mg/L. The monitoring station is within an area of groundwater impact associated with the Archer, Daniels, Midland gypsum stack located approximately 0.3 miles to the west (NCDEQ Groundwater Incident #17503). Multiple shallow monitoring wells exist to the west of Site #3, and GMA anticipates that the elevated TDS in the Surficial Aquifer is associated with calcium, sulfate, and other dissolved solids leaching into the groundwater from the nearby gypsum stack. At present, we do not see any evidence of saltwater intrusion from the Cape Fear River into the Surficial, Castle Hayne, or Peedee Aquifer at Site #3.

4.5 WATER-LEVEL MONITORING

A critical aspect of updating the groundwater flow model is to calibrate the model to observed water levels at specific locations within the model domain. The new monitoring well stations provide supplemental groundwater elevation data in key locations. Upon completion of the monitoring wells, each well was equipped with a locking steel aboveground well cover and was protected with bollards. This wellhead completion provides fixed, protected points of reference at the wellhead for monitoring the depth to the water level at each well. Hand measurements of water level depths were made during aquifer testing and during sampling. In addition, GMA measured the depths to water levels in each well during the deployment of pressure transducers/data loggers. Hand measurements were collected using an electronic water-level meter, and depths to water levels were referenced to the top of the well casing at each well.

To tie water depth measurements to a common datum, GMA contracted a registered land surveyor to establish the location (NC State Plane Coordinates – NAD 1983) and elevation (NAVD88) of the top of the well casing at each monitoring well. Survey data are included in Appendix V. Table 5 lists the hand measurements of water levels measured at each monitoring well. All water-level measurements have been adjusted to groundwater elevations.

Continuous water-level monitoring data were also collected from each monitoring well from October 4, 2017 through November 1, 2017 using dedicated pressure transducers/data loggers. The transducers were set to collect water level measurements every 15 minutes. The transducer data were adjusted for elevation so that a continuous record of groundwater elevations in the Surficial, Castle Hayne (or Fluvial at Site #1), and Peedee Aquifers could be presented. Figures 14 through 16 illustrate the groundwater elevation data collected.

4.5.1 Water-Level Data from Site #1 (Front Street)

At Site #1 (Front Street – Wilmington), the Surficial Aquifer groundwater elevation is typically approximately 0.25 to 0.5 feet lower than the head observed in the Fluvial and Peedee Aquifer wells (Figure 14). In addition, all head values at Site #1 were at least 1.0 foot above mean sea level. These data demonstrate that the Fluvial Sand Aquifer and the Peedee Aquifer at Site #1 are higher head than the Surficial Aquifer and the Cape Fear River, thus these deeper aquifer units discharge groundwater into the Cape Fear River. In addition, the head in the Fluvial Sand and Peedee Aquifer units are nearly identical throughout the monitoring period. This indicates that the two units are not separated by an effective confining layer in the area.

Clear evidence of tidal water-level fluctuations is noted from the continuous water-level monitoring data at Site #1 (Figure 14). The observed tidal influence on the groundwater levels demonstrates that the Cape Fear River channel in the area of Site #1 is hydraulically connected to the Surficial, Fluvial, and Peedee Aquifer units. The tidal cycles in the groundwater at Site #1 lag behind the observed tides in the Cape Fear River. The Fluvial and Peedee Aquifer tides lag by approximately 40 to 50 minutes following the tidal peaks in the river. The tidal lag in the Surficial Aquifer is approximately 80 minutes after high tide in the river. The longer tidal lag in the Surficial Aquifer predominantly results from the high storage coefficient of the unconfined aquifer. The Fluvial and Peedee Aquifers are confined to semi-confined and have a significantly lower storage coefficient.

4.5.2 Water-Level Data from Site #2 (Fort Fisher Ferry)

Groundwater elevation data from the Fort Fisher Ferry site demonstrate a downward head gradient between the Surficial, Castle Hayne, and Peedee Aquifers, with the higher head typically occurring in the Surficial Aquifer and the lowest head occurring in the Peedee Aquifer. The elevations of groundwater levels observed at Site #2 ranged from 3.39 to 0.17 feet above mean sea level.

Prominent tidal fluctuations are evident in all three aquifers at Site #2 (Figure 15). This indicates direct hydraulic connection between the Cape Fear River (and /or the Atlantic Ocean) and the groundwaters of the Surficial, Castle Hayne, and Peedee Aquifers. The Peedee Aquifer exhibited the lowest head at Site #2, reflecting the local utilization of the Peedee Aquifer for water supply at nearby water systems in Kure Beach and Carolina Beach. In addition, the Fort Fisher Ferry site operates a Peedee Aquifer water-supply well at the site for bathroom services. The well is not used for drinking water due to exceedance of drinking water standards for TDS and chloride.

Tidal peaks in the three monitoring wells lagged behind the high and low tides documented at Tide Station #894, which is located at the Fort Fisher Ferry Landing. The Surficial Aquifer tides occurred approximately 75 minutes after the recorded tide cycles in the Cape Fear River. The tide peaks recorded in the Castle Hayne and Peedee monitoring wells occurred approximately 50 and 70 minutes, respectively, after the tide peaks in the Cape Fear River. Available data indicate that the Castle Hayne and Peedee Aquifers at the Fort Fisher Ferry site are semi-confined aquifers. Drilling data from Site #2 indicate that the Castle Hayne Aquifer has a very thin (<10 feet thick) silty confining layer that separates the Castle Hayne Aquifer from the Surficial Aquifer. This shallow and thin semi-confining layer likely has been breached locally by erosion, either in the Cape Fear River channel or off-shore in the ocean. The very high salinity of groundwater in the Castle Hayne Aquifer at Site #2 provides supporting evidence for the low degree of confinement of the aquifer.

The Peedee Aquifer exhibits a more substantial clay confining layer from approximately 113 to 145 feet depth at Site #2. The hydraulic head in the Castle Hayne Aquifer above the Peedee confining layer is approximately 1 foot higher than the head below the confining layer in the Peedee Aquifer (Figure 15). In addition, the salinity of the Peedee is only about 6% of the salinity measured in the Castle Hayne Aquifer at Site #2. So, the Peedee confining layer does serve as a significant local confining unit. However, the strong tidal response observed in the Peedee Aquifer monitoring well indicates that the Peedee confining layer may not be laterally continuous. This is consistent with prior work by GMA (2007) where the Peedee confining layer was absent in parts of the Carolina beach wellfield approximately 4.5 miles north of Site #2. So, a strong tidal response in the Peedee Aquifer is not surprising at the Fort Fisher Ferry site.

4.5.3 Water-Level Data from Site #3 (Southport)

The Southport monitoring well station exhibits a significant downward head gradient between the Surficial, Castle Hayne, and Peedee Aquifers (Figure 16). The Surficial Aquifer has a hydraulic head that is on average about 10 feet higher than the head in the Castle Hayne Aquifer. Head in the Castle Hayne Aquifer is, on average, approximately 6.5 feet higher elevation than the head in the underlying Peedee Aquifer. These head differences demonstrate significant confinement of the Castle Hayne and Peedee Aquifers at the Southport station than at the other two monitoring well stations.

Tidal fluctuations are clearly evident in water levels in the Castle Hayne and Peedee Aquifers at Site #3. Tidal fluctuations in the Castle Hayne Aquifer monitoring well averages about 2 feet, and the tidal fluctuations in the Peedee Aquifer monitoring well averages approximately 1 foot (Figure 16). The observed tidal fluctuations at Site #3 were compared to the nearest tide station (Station 3057 at Zeke's Island), and the tidal peaks lagged by 40 minutes in the Castle Hayne well and 60 minutes in the Peedee well. The Zeke's Island tide station is approximately 2 miles east-northeast from Site #3. So, the tidal lag times estimated from the monitoring wells are not as precise as other stations due to the distance from Site #3 to the tide station. Water levels in the Surficial Aquifer monitoring well at Site #3 did not exhibit tidal effects.

The water-level data from the Peedee Aquifer monitoring well indicates that a significant decline in head has occurred in the Peedee Aquifer near Southport since Lautier (1998) conducted his groundwater model. In 1998, the head in the Peedee Aquifer at Southport was equal or higher elevation than sea level, supporting the conclusion that the Peedee Aquifer was discharging into, or had the potential to discharge into, the Cape Fear River. This is no longer the case. The head decline in the Peedee Aquifer at Southport appears to be related to the Archer Daniels Midland (ADM) and Duke Energy Brunswick Power Plant (Brunswick Plant) groundwater withdrawals. Because the Peedee Aquifer at Site #3 has fresh water quality, there is currently no evidence for ongoing saltwater intrusion into the Peedee from the Cape Fear River channel. However, there could be an incipient saltwater plume in the Peedee Aquifer beneath the river channel that has not moved far enough to the west to be detected by the monitoring well at Site #3. This possibility will need to be addressed through groundwater modeling.

5.0 Site Conceptual Model

The critical question to be addressed by groundwater modeling is: Will deepening and widening of the Cape Fear River, as proposed for the Section 203 Navigation Channel Improvement, induce or accelerate saltwater intrusion into the shallow aquifers beneath and/or adjacent to the channel? Prior modeling conducted by Lautier (1998) concluded that the Cape Fear River was an area of discharge from the groundwater system. As such, the discharge of water from the aquifers into the Cape Fear River channel was projected to prevent the intrusion of brackish water into the aquifers from the river. Considering this discharging condition, Lautier did not conduct extensive modeling of salinity changes in the groundwater system. However, increased groundwater utilization in New Hanover and Brunswick Counties has locally reversed the hydraulic head trends in areas along the Cape Fear River. These reversals are most notable near the Carolina Beach wellfield and in Brunswick County near the ADM and Brunswick Plant. Simulations of saltwater intrusion (i.e., solute transport) will be necessary to evaluate the existing, and projected future, conditions following Section 203 Navigation Channel Improvements.

Modeling will focus on three shallow aquifers: the Surficial (which is unconfined), the Castle Hayne/Fluvial (semiconfined to confined), and the Peedee Aquifer (semiconfined to confined). GMA will build upon the Lautier (1998) finite element model that was used for decisions regarding the most recent navigation channel improvements. As with Lautier's model, GMA will assume that the Black Creek Confining Layer is a no-flow boundary, and that unit will be the base of the model. GMA will review each of the input parameters used by Lautier, and we will make necessary adjustments in light of new available data. Model input parameters to be reviewed will include:

- Hydrostratigraphic Framework – GMA will evaluate the hydrostratigraphic framework used by Lautier. We will incorporate available new well drilling data generated from local wellfield construction that has occurred since 1998. We will also incorporate hydrostratigraphy data determined by GMA's monitoring well installation program. Elevations and thicknesses of aquifers and confining layers in the model will be adjusted based upon this new data.
- Hydraulic Conductivity – GMA generated new hydraulic conductivity values from the monitoring well installation program. In addition, some hydraulic conductivity data are available from aquifer tests on new water-supply wells that have been constructed since 1998. We will incorporate these new permeability values into the model and perform iterative recalibration of the model using these new data.
- Recharge – GMA anticipates that recharge values used by Lautier will not be adjusted, unless we recognize calibration difficulties using Lautier's values. We will review Lautier's inputs and compare these to other regional recharge assumptions that have been used by the United States Geological Survey and others in the region.
- Groundwater Withdrawals – GMA will update the model to incorporate the expanded groundwater withdrawals that have been discussed previously in this report.
- Hydraulic Head – Previous model calibration by Lautier used hydraulic head from 1993-1994 as the base simulation. GMA will access available online data from the North Carolina Department of Environmental Quality (NCDEQ) Division of Water Resources (DWR) groundwater management branch databases. We will utilize head data from 2017 as our base simulation for calibration. We will supplement the NCDEQ data with groundwater elevation data from GMA's monitoring well stations.
- Groundwater Quality Data – The NCDEQ-DWR includes mapping of chloride values for aquifers in the Coastal Plain. These water-quality data are predominantly from regional monitoring well stations monitored by the NCDEQ-DWR and the USGS. Unfortunately, many of the regional monitoring wells are not sampled regularly for chloride concentrations, so the evidence for saltwater occurrence may not be complete from these data. GMA will supplement the NCDEQ-DWR and USGS data with water-quality results from the three monitoring well sites constructed for this project. We also will integrate available water-quality data from water-supply wells in the region.
- Navigation Channel Dimensions – GMA will review Lautier's depictions of the navigation channel in 1998, and we will compare to the recent channel survey completed by Fugro (2018). If there are significant discrepancies in the channel depth simulated by Lautier versus the Fugro channel survey, GMA will make model adjustments prior to calibration. After achieving calibration to base conditions, GMA will perform separate simulations of channel geometry based upon the proposed channel improvements.
- Boundary Conditions – Lautier used a variety of hydraulic boundaries in the model simulations. These included: a No-Flow boundary at the base of the model, a Constant Head boundary along the Cape Fear River, a Constant Head boundary at the Atlantic Ocean, variable Specified Heads at nodes along the northern and western model perimeters to account for regional head in 1993-1994, a Specified Flux boundary for recharge contributions, and Point Sink boundaries to simulate groundwater withdrawals

by wells that pumped more than 10,000 gallons per day. GMA will adjust the variable Specified Heads along the northern and western model perimeters to account for regional head conditions in 2017. We will also modify the Point Sink boundaries to account for new and expanded groundwater withdrawals in the model domain.

The adjustment to model parameters will lead to new baseline simulations of current conditions. The focus of these simulations will be to address, as accurately as is feasible with available data, the groundwater head and water-quality conditions along the Cape Fear River. Because the critical question being addressed by this study relates specifically to the navigation channel interactions with the groundwater system, our primary focus of evaluation modeling will be on river/aquifer interactions. Distant influences on the groundwater system (such as individual pumping wells in wellfields that are more than a 2 miles away from the channel) may not accurately reflect the head in the aquifers *within* the wellfields. But, the effects of these wellfields on head in the aquifers adjacent to/in contact with the Cape Fear River will be accurately reflected in the modeling. Modeling of pumping induced water-level changes will be critical for evaluating the interactions between the river channel and the aquifer system adjacent to and beneath the navigation channel. Acceptable recalibration of the model will be based upon close agreement of modeled and observed head along the river channel, including close comparison of head in the monitoring wells at Sites #1 through #3 that were installed as a part of this study.

6.0 Conclusions

GMA has completed the installation of monitoring well stations at three key positions adjacent to the Cape Fear River. These monitoring wells provide data on hydraulic head, water quality, aquifer hydraulic conductivity, and hydraulic connection between tides in the river and the aquifers monitored in the monitoring well stations. These data are critical to updating the groundwater flow model for current conditions. Based upon findings of the monitoring well program, GMA concludes the following:

- Site #1 at Front Street in Wilmington:
    - The Castle Hayne Aquifer is absent at this site. This unit likely was removed by erosion. A fluvial sand deposit, overlain by a thin semi-confining clay bed, occurs in the stratigraphic position where the Castle Hayne Aquifer would normally be expected. The fluvial sand unit likely was deposited by a paleo-channel of the ancestral Cape Fear River.
    - Hydraulic head in the Surficial, Castle Hayne (Fluvial), and Peedee Aquifers are directly affected by tidal cycles in the Cape Fear River. No effective confining layer for the Fluvial or Peedee aquifers is indicated. Hydraulic head in these aquifers remains above mean sea level, indicating that the groundwater system discharges to the Cape Fear River in this area. This is consistent with findings by Lautier (1998).
    - Water quality in the Fluvial and Peedee Aquifer units is fresh, and we found no evidence of saltwater intrusion from the Cape Fear River into these deeper units at the site. The Surficial Aquifer well contains brackish groundwater consistent with local intrusion of brackish water from the river. The monitoring well site is located adjacent to a tidal marsh, and the site is subject to local flooding during

high tides or during storm events. Brackish water in the Surficial Aquifer associated with tidal marsh areas is expected and would not be related to channel dredging.

- Site #2 at Fort Fisher Ferry Landing:
    - The Surficial, Castle Hayne, and Peedee Aquifers are tidally influenced at Site #2. Tidal fluctuations in the Surficial Aquifer average about 0.5 feet. Tidal fluctuation in the Castle Hayne and Peedee Aquifers average about 1 foot. There is a downward directed head gradient between the Surficial, Castle Hayne, and Peedee Aquifers at the site. Head values observed for all aquifers were above mean sea level.
    - The Castle Hayne Aquifer is overlain by a thin (<10 feet thick) semi-confining layer. This unit likely is laterally discontinuous and serves as a poor confining layer. The Castle Hayne Aquifer is likely exposed to the Atlantic Ocean offshore. In addition, the Castle Hayne Aquifer is likely hydraulically connected to the Cape Fear River channel to the west. The Peedee Aquifer confining layer is approximately 30 feet thick at Site #2. This layer serves as a locally effective confining layer, as evidenced by the head and water-quality differences between the Castle Hayne and Peedee Aquifer units. However, the strong tidal response of the Peedee Aquifer indicates that the Peedee confining layer is not laterally extensive. In fact, the Peedee confining layer is known to be absent at some locations near Carolina Beach, approximately 4.5 miles north of Site #2.
    - The Castle Hayne Aquifer contains very high salinity, approximately 2/3 the salinity of sea water. The high salinity of the Castle Hayne Aquifer at Site #2 is a testament to the lack of confinement of the aquifer and the direct hydraulic connection to high-salinity water in the ocean and beneath the Cape Fear River channel to the west. The Castle Hayne Aquifer salinity is a function of natural conditions of the system and is not a result of dredging.
    - The groundwater quality of the Peedee Aquifer at Site #2 is slightly brackish (about 2 times the groundwater quality standards for chloride and TDS). The Peedee Aquifer is known to contain fresh groundwater to the north at Carolina Beach and Kure Beach, so the freshwater/saltwater interface in the Peedee Aquifer lies just to the north of Site #2. The depth of burial of the Peedee Aquifer (145 feet) at Site #2 makes it too deep to be affected by the proposed dredging. The presence of brackish water in the Peedee Aquifer at Site #2 is from the intrusion of Atlantic Ocean water from off-shore areas. The continued, and expanded withdrawals of groundwater from the Peedee Aquifer at Carolina Beach and Kure Beach may induce lateral (northward) intrusion of the freshwater/saltwater interface. Future monitoring of salinity at Site #2 may help to predict the rates of saltwater migration.
- Site #3 at Southport:
    - The Southport monitoring well station is on an elevated terrace that is approximately 25 feet above sea level. The water table in the Surficial Aquifer at the site is at approximately 12 feet above mean sea level. This groundwater elevation is substantially higher than the Cape Fear River, and the Surficial Aquifer discharges to the Cape Fear River. No tidal influence is evident for the Surficial Aquifer at Site #3.
    - The hydraulic head in the Castle Hayne Aquifer averages approximately 2 feet above mean sea level. This presents a potential for groundwater discharge from

the Castle Hayne Aquifer into the river. The confining layer above the Castle Hayne is approximately 35 feet thick, which indicates that directly beneath the site and west of the site the Castle Hayne is confined at the site. However, the elevation of the top of the Castle Hayne Aquifer is about -35 feet MSL. Prior dredging of the navigation channel likely has breached the Castle Hayne confining layer to the east of Site #3, and breaching of the confining layer would explain the approximately 2 feet of tidal fluctuation that was observed in the Castle Hayne monitoring well.

- The Peedee Aquifer at Site #3 is overlain by an almost 40 feet thick clay confining layer. This is a very effective local confining layer, as evidenced by the approximately 10 feet of head difference between the Peedee and the Castle Hayne Aquifers. However, the Peedee Aquifer exhibits an obvious tidal fluctuation of approximately 1 foot, suggesting that the Peedee Aquifer is open to tidal water relatively close to the site. As was described for Site #2, the confining layer separating the Peedee and Castle Hayne aquifers in the region may have significant lateral variations, and in some areas the confining layer may be absent. While the current study did not identify a specific local hydraulic connection between these two aquifers, it is appropriate to assume that the confining layer is leaky in the vicinity of Site #3. The top of the Peedee Aquifer in the vicinity of Site #3 occurs at an elevation of approximately -100 feet MSL. This depth is well below the dredging depth of the Cape Fear River, so GMA concludes that dredging has not caused breaching of the confining layer, and the leaky condition of the Peedee confining layer near Site #3 must be intrinsic to the aquifer system.
- The Peedee Aquifer at Site #3 appears to be affected by groundwater withdrawals. The hydraulic head in the Peedee Aquifer was observed at -3.5 feet MSL to -8 feet MSL. This same area exhibited hydraulic head above mean sea level in 1994 (Lautier, 1998). Withdrawals from the Peedee Aquifer at the ADM facility and at the Duke Energy Brunswick Power Plant have induced a cone of depression that extends to the Cape Fear River. Site #3 lies within this new cone of depression. Because the head in the Peedee Aquifer adjacent to the river is now below sea level as a result of groundwater withdrawals, there is a hydraulic potential for brackish water in the Cape Fear River to drain down vertically into the Peedee Aquifer, especially if the Peedee confining layer is thinned or absent beneath the river. However, water from the river would have to pass through the Castle Hayne Aquifer on its path downward to the Peedee Aquifer, and the higher head in the Castle Hayne unit may serve as a hydraulic barrier to downward movement of Cape Fear River water into the Peedee Aquifer.
- Water-quality data from the Surficial, Castle Hayne, and Peedee Aquifers at Site #3 is fresh. There is no evidence of ongoing saltwater intrusion into the aquifers screened at Site #3. The elevated TDS observed in the Surficial Aquifer monitoring well is not saltwater related, as evidenced by the very low chloride concentration in that well. Rather, the elevated TDS is a result if a contaminant plume extending from the ADM gypsum stack located approximately 1500 feet west of Site #3. Numerous shallow monitoring wells occur in the open field west of Site #3, and these wells are associated with ongoing groundwater quality monitoring of the contaminant plume from the ADM facility.

The site conceptual model that will be the basis of the updated groundwater flow model will remain reasonably consistent with previous modeling conducted by Lautier (1998). Significant modifications to Lautier's conceptual model include the following:

- The reference baseline water levels for calibration will be from 2017. Lautier's model boundary conditions will be adjusted to reflect current groundwater-level conditions.
- The hydrostratigraphic framework of the model domain will be adjusted to incorporate data from wells drilled in the area since 1998.
- Point Sinks will be added in the model to account for expanded groundwater utilization in the region since 1998. Most notable expansions of groundwater withdrawals include the CFPUA wellfield near Ogden, the expansion of the Carolina Beach wellfield, expanded withdrawals from the Castle Hayne Aquifer at Southport, and the new Peedee Aquifer cone of depression associated with withdrawals in Brunswick County by ADM and Duke Energy.
- Baseline groundwater quality data will be updated to incorporate results of the groundwater monitoring well program as well as data from water-supply wellfield expansions. Prominent in this water-quality update is the recognition of brackish groundwater in the Castle Hayne Aquifer near Fort Fisher. Prior studies indicated that salinity of the Castle Hayne in that area was nearly fresh, with chloride concentrations of <600 mg/L (Lautier, 1998). The Site #3 monitoring well station demonstrated that chloride concentrations exceeding 9000 mg/L occur in the Castle Hayne Aquifer in that region.
- Aquifer hydraulic properties as determined from the monitoring well program will be incorporated into the groundwater flow model. In addition, available aquifer test data from wellfield expansions in the region will also be used to update the hydraulic conductivity values used for specific aquifer layers in the groundwater model.

The updated groundwater modeling will provide indications of whether or not the proposed Port of Wilmington Section 203 Navigation Channel Improvements are likely to induce saltwater intrusion into the groundwater adjacent to the river. These results will be important for the NC State Ports Authority to plan and implement navigation channel improvements.

7.0 Report Certification

This report was prepared by Groundwater Management Associates, Inc., a professional corporation licensed to practice geology (#C-121) and engineering (#C-0854) in the state of North Carolina.

James K Holley

SEAL 2/6/19
1060
JAMES K. HOLLEY

James K. Holley, PG
Senior Hydrogeologist

Emma H. Shipley, PG
Project Hydrogeologist

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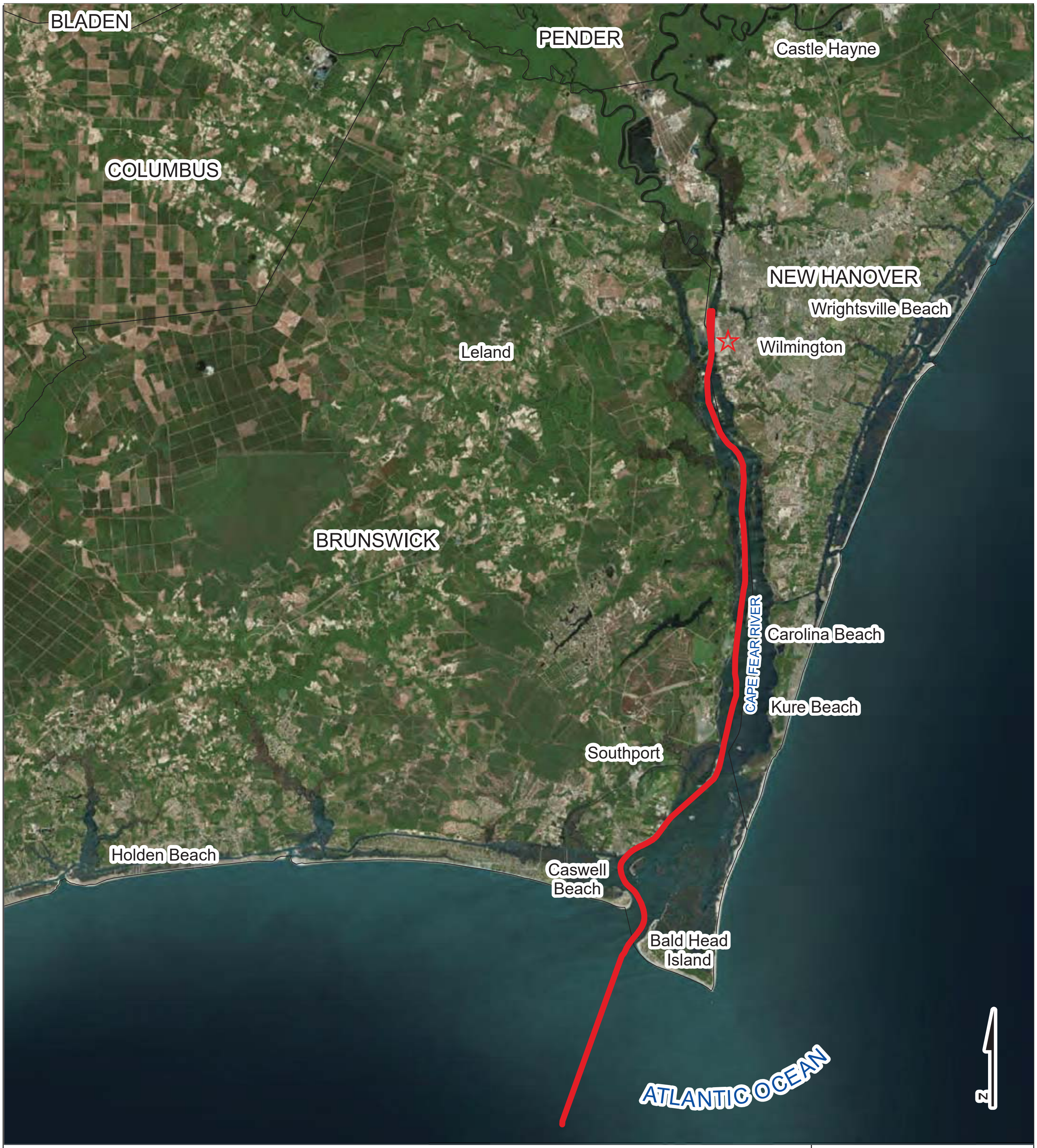
Figures



LEGEND

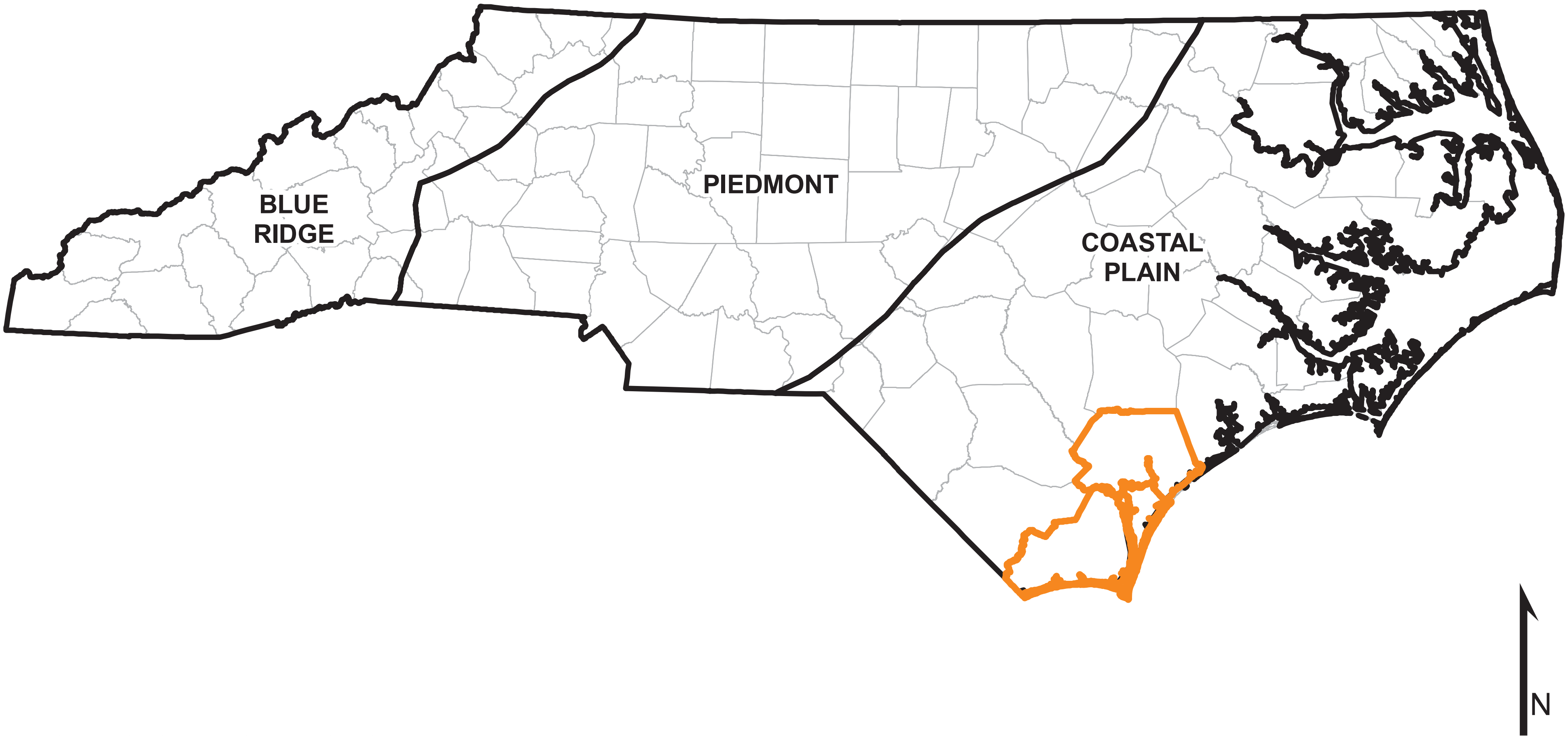
☆ WILMINGTON PORT

— NAVIGATION CHANNEL

0 15,000 30,000
Feet

GMA

File: DRAWINGS/16001/ DREDGE_CHANNEL_LOCATION	MAP OF THE CAPE FEAR RIVER SHOWING THE WILMINGTON PORT AND PROPOSED DREDGE CHANNEL	Date: 4/13/2018
Project No. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	Figure 1



PHYSIOGRAPHIC PROVINCES MODIFIED FROM NCGS, 1985

-LEGEND-

🟧 NEW HANOVER, BRUNSWICK, & PENDER COUNTIES

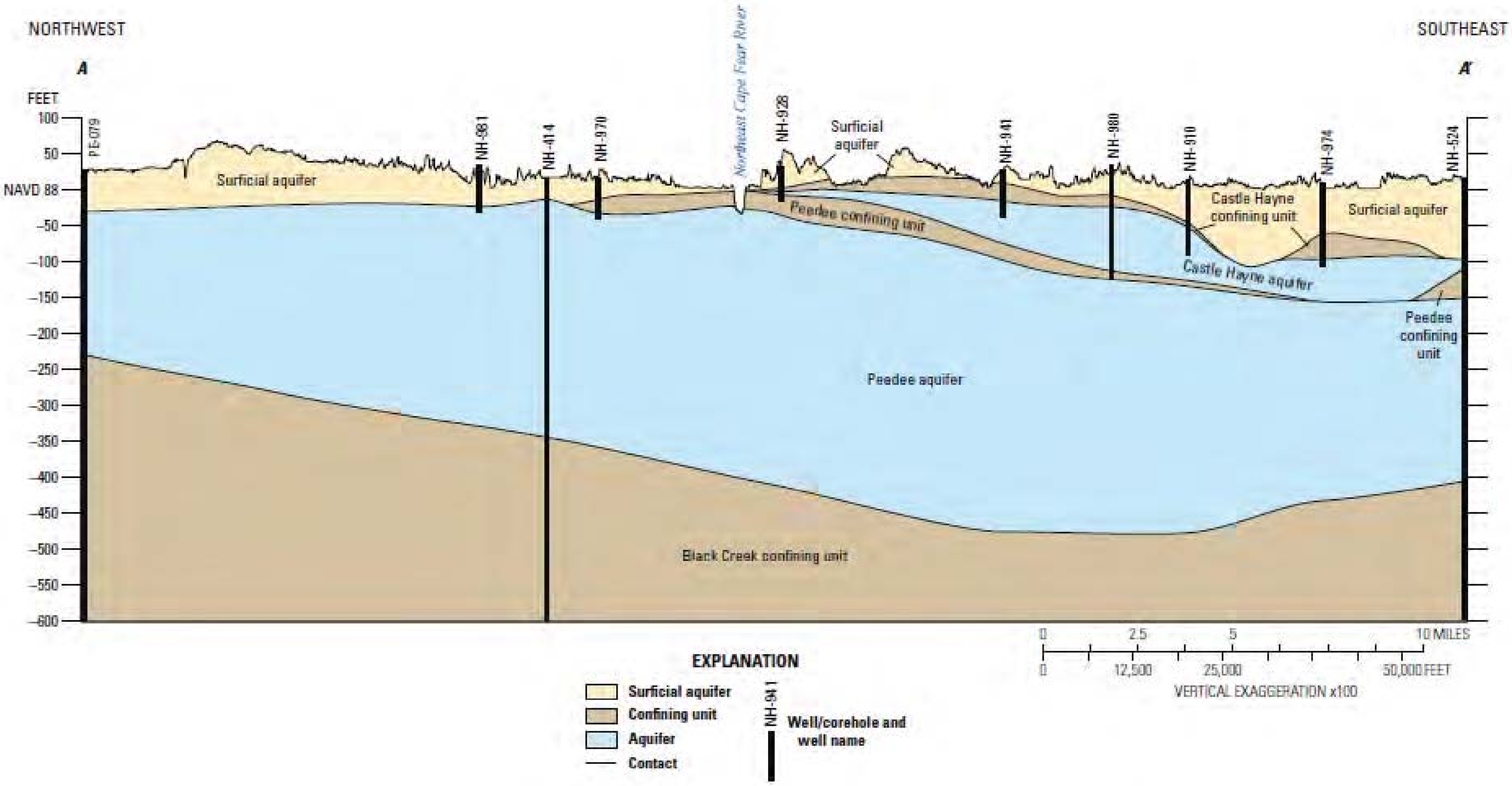
⬛ PHYSIOGRAPHIC REGIONS

☐ COUNTY BOUNDARIES

0 25 50 Miles

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/ PHYSIOGRAPHIC	PHYSIOGRAPHIC PROVINCES OF NORTH CAROLINA SHOWING THE STUDY AREA LOCATION	Date: 04/13/2018
PROJECT 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 2

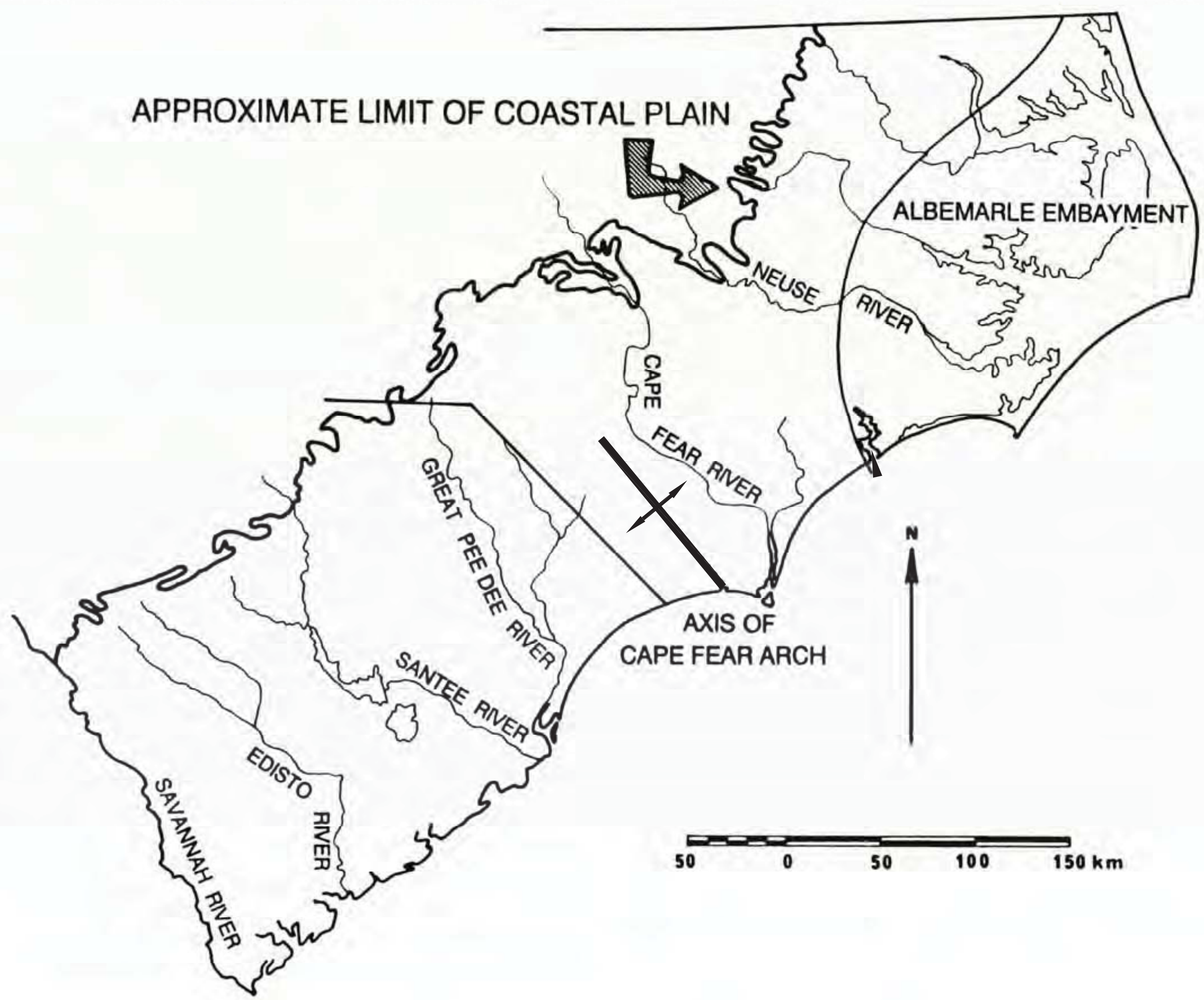


SOURCE: MCSWAIN & OTHERS, 2014 (SIR2014-5169)

-LEGEND-

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/ FIG 7 X SECT	REGIONAL CROSS SECTION OF AQUIFERS IN THE COASTAL PLAIN NEAR WILMINGTON	Date: 04/16/2018
PROJECT 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 3



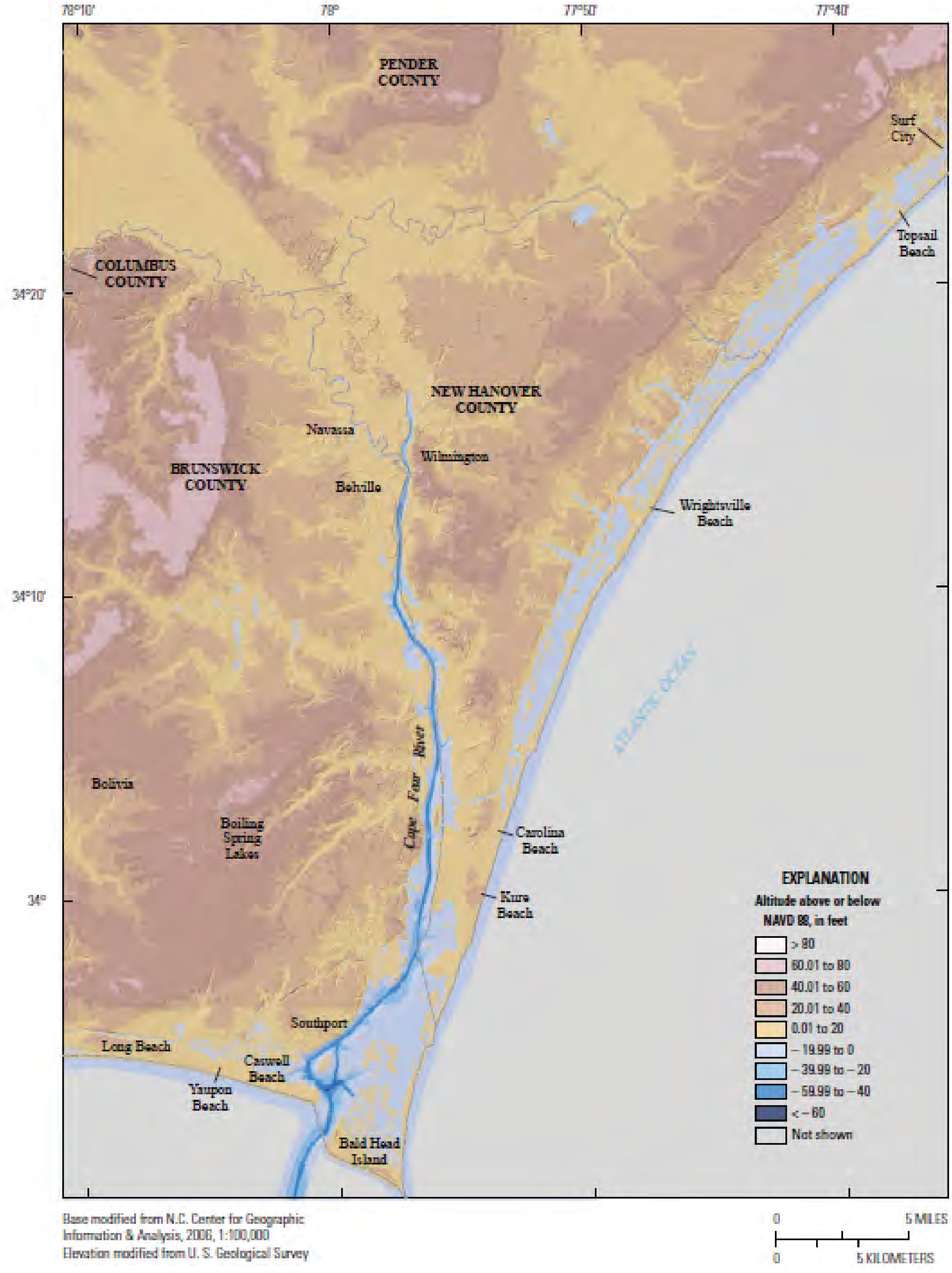
ADAPTED FROM HARRIS AND ZULLO, 1991

LEGEND

╳ ARCH

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/ARCH	LOCATION OF THE CAPE FEAR ARCH	Date: 4/13/2018
Project No. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	Figure 4



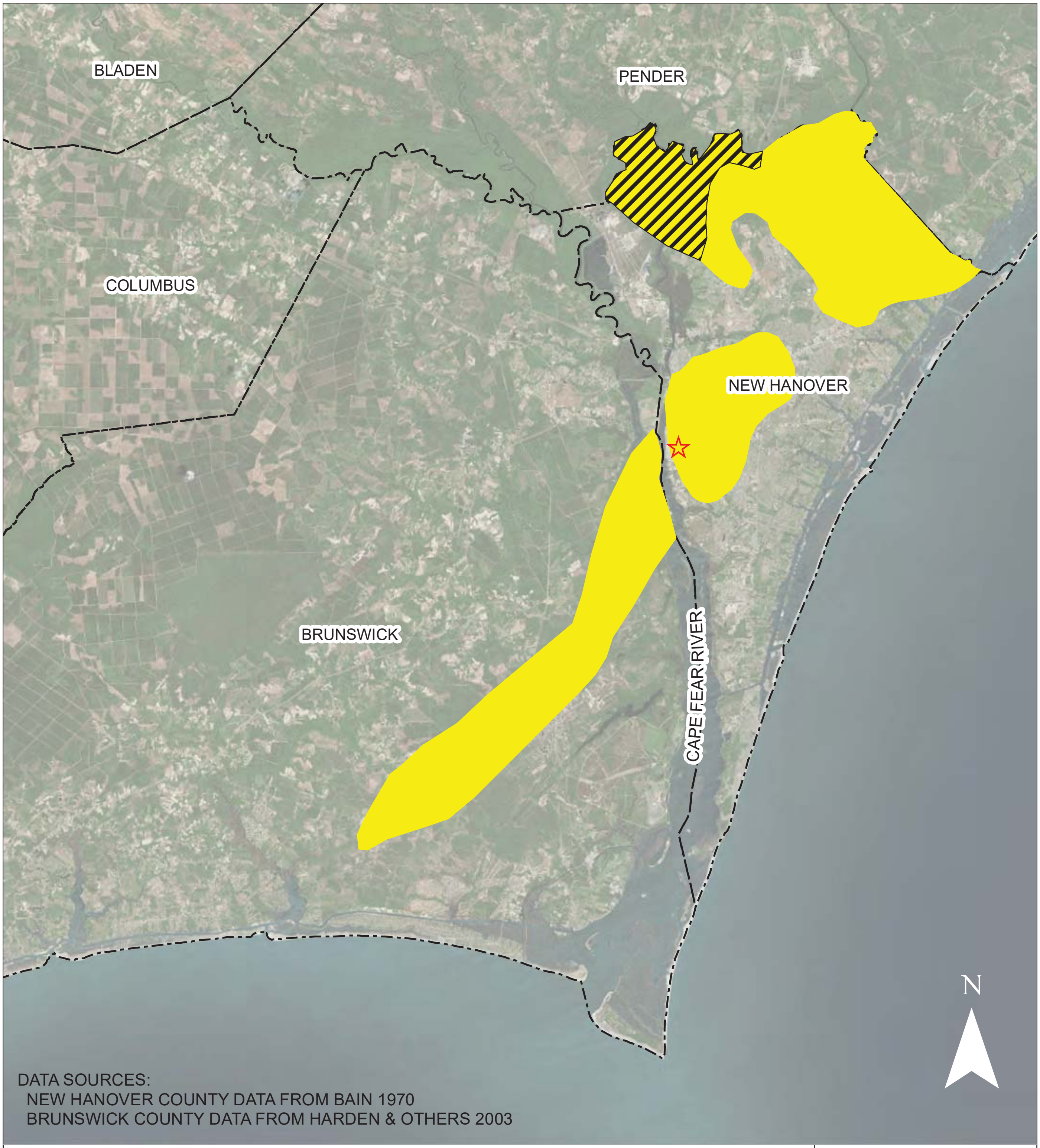
Base modified from N.C. Center for Geographic Information & Analysis, 2006, 1:100,000
Elevation modified from U. S. Geological Survey

SOURCE: MCSWAIN & OTHERS, 2014 (SIR2014-5169)

-LEGEND-

GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/ TOPOGRAPHY	TOPOGRAPHY OF EASTERN BRUNSWICK AND NEW HANOVER COUNTIES	DATE: 4/13/2018
PROJECT 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 5



DATA SOURCES:
NEW HANOVER COUNTY DATA FROM BAIN 1970
BRUNSWICK COUNTY DATA FROM HARDEN & OTHERS 2003

LEGEND

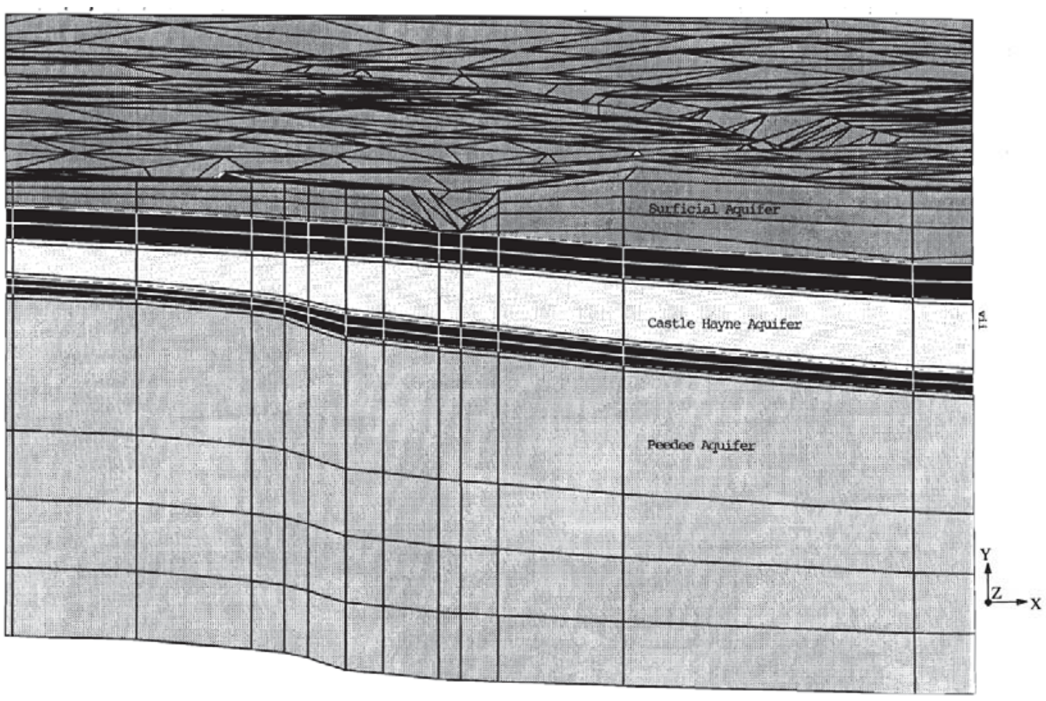
☆ WILMINGTON PORT

▨ PEEDEE SANDSTONE

🟨 ESTIMATED AREA OF INDURATED LIMESTONE AND/OR SANDSTONE AT -10 FT MSL OR HIGHER ELEVATION

0 15,000 30,000'

FILE: DRAWINGS/160001/ INDURATED_Ls_Ls_20180322	MAP OF INDURATED ROCKS OF THE CASTLE HAYNE AND PEEDEE FORMATIONS IN THE SHALLOW SUBSURFACE	DATE: 4/13/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 6



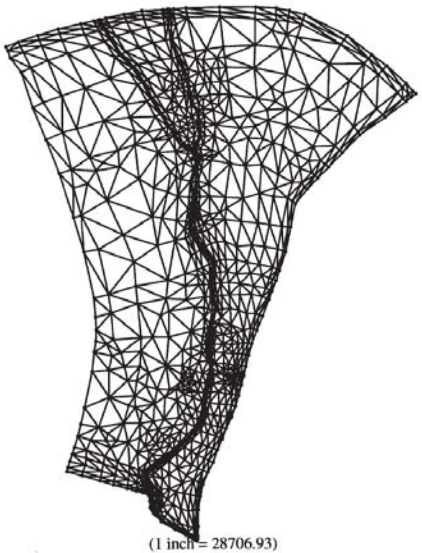


Figure V: Top view of 3-D Mesh

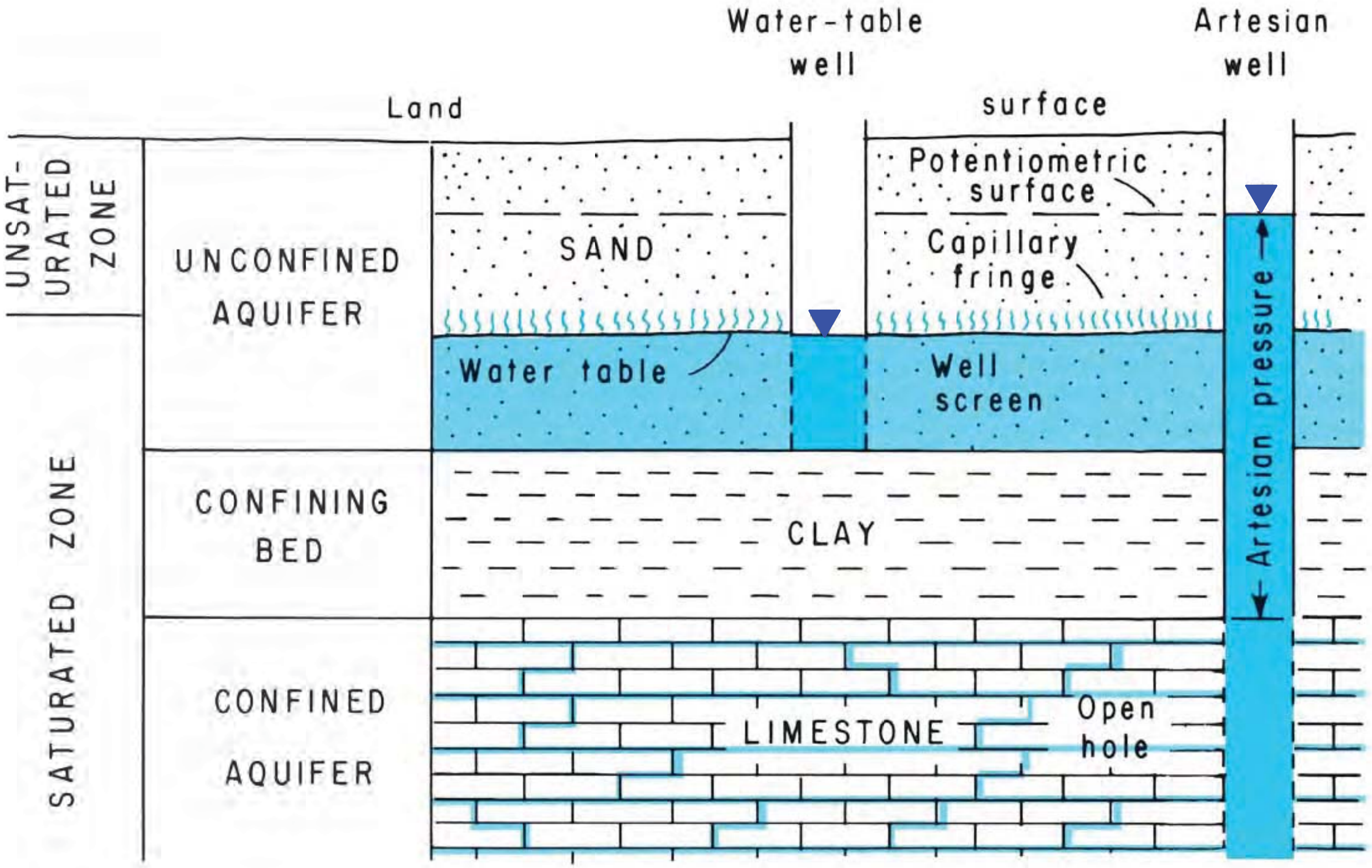
- LEGEND -

FIGURE 7

DATE: 4/16/20018 PROJECT: 160001
DRW BY: KAS

MODEL GRID AND COSS-SECTIONAL
VIEW FROM LAUTIER, 1998

GROUNDWATER MANAGEMENT ASSOCIATES, INC.



MODIFIED FROM HEATH, 1983

— LEGEND —

▼ WATER LEVEL MARKER

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/CONFINED-UNCONFINED

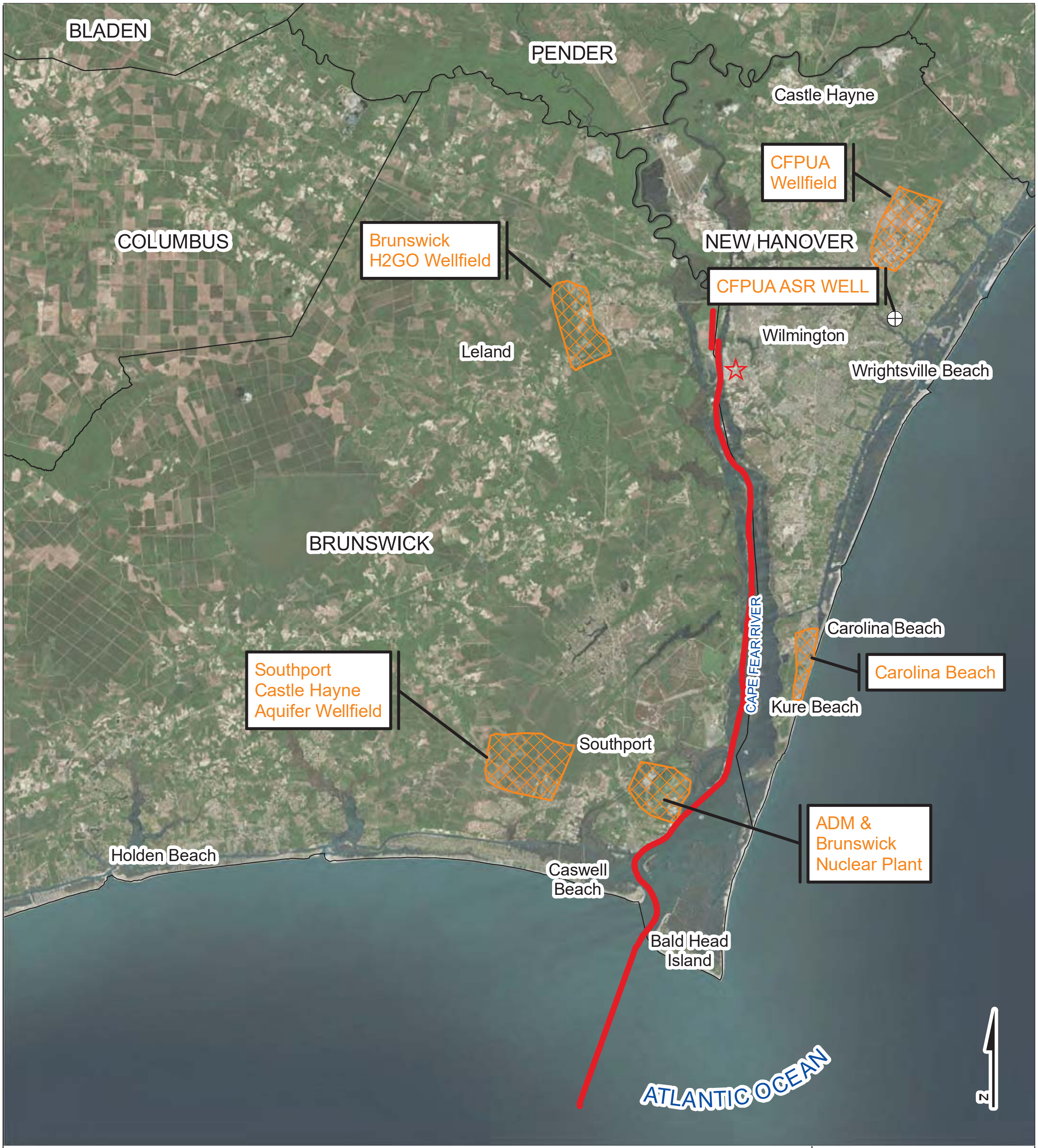
Project No. 160001

CONFINED AND UNCONFINED AQUIFERS

PORT OF WILMINGTON
SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

Date: 4/13/2018

Figure 8



LEGEND

☆ WILMINGTON PORT

▬ NAVIGATION CHANNEL

▨ EXPANDED GROUNDWATER WITHDRAWAL AREA

0 15,000 30,000

Feet

GMA

File: DRAWINGS/16001/ EXPANDED_WITHDRAWALS	LOCATIONS OF EXPANDED GROUNDWATER WITHDRAWALS IN NEW HANOVER AND BRUNSWICK COUNTIES	Date: 4/16/2018
Project No. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	Figure 9

LEGEND

- ● SITE 1- FRONT STREET
- ● SITE 2- FORT FISHER
- ● SITE 3- SOUTHPORT
- ☆ WILMINGTON PORT

0 15,000 30,000 Feet

GMA

File: DRAWINGS/16001/ LOCATION OF MONITORING WELL SITES	LOCATION OF MONITORING WELL SITES	Date: 4/13/2018
Project No. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	Figure 10

LEGEND

⊕ MONITORNG WELL

GMA

File: DRAWINGS/16001/
SITE #1-FRONT STREET

MONITORING WELL SITE #1 - FRONT STREET, WILMINGTON

Date: 4/13/2018

Project No. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

Figure 11

LEGEND

⌖ MONITORING WELL

― ROADS

GMA

File: DRAWINGS/16001/ SITE #2-FT. FISHER	MONITORING WELL SITE #2 - FORT FISHER FERRY LANDING	Date: 4/13/2018
Project No. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	Figure 12

LEGEND

⊕ MONITORING WELL

GMA

File: DRAWINGS/16001/ SITE #3-SOUTHPORT	MONITORING WELL SITE #3 - SOUTHPORT	Date: 4/13/2018
Project No. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	Figure 13

FIGURE 14 - WATER-LEVEL MONITORING DATA FROM SITE #1 - FRONT STREET

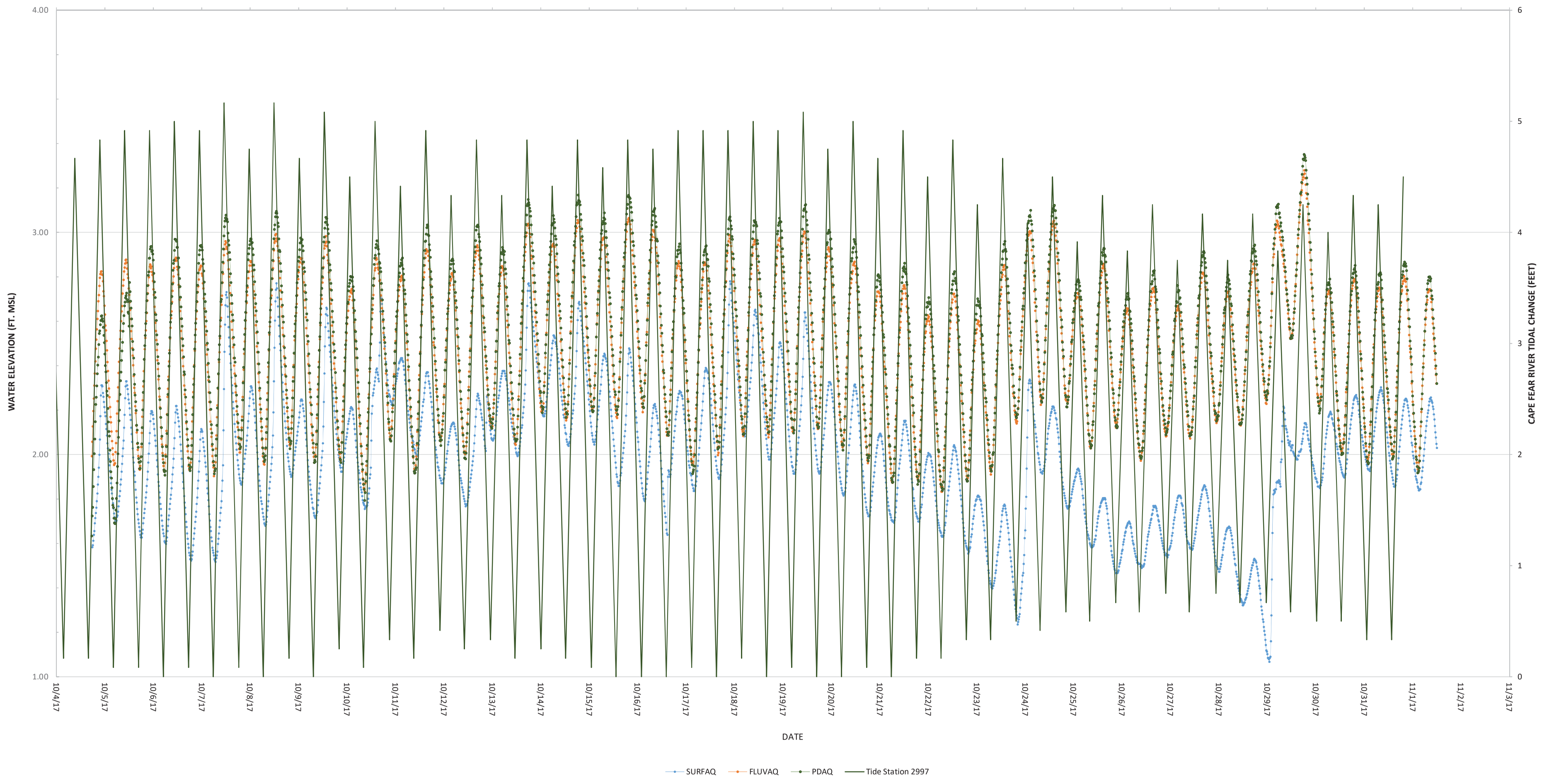


Figure 15. Water-Level Monitoring Data from Site #2 – Fort Fisher Ferry Landing

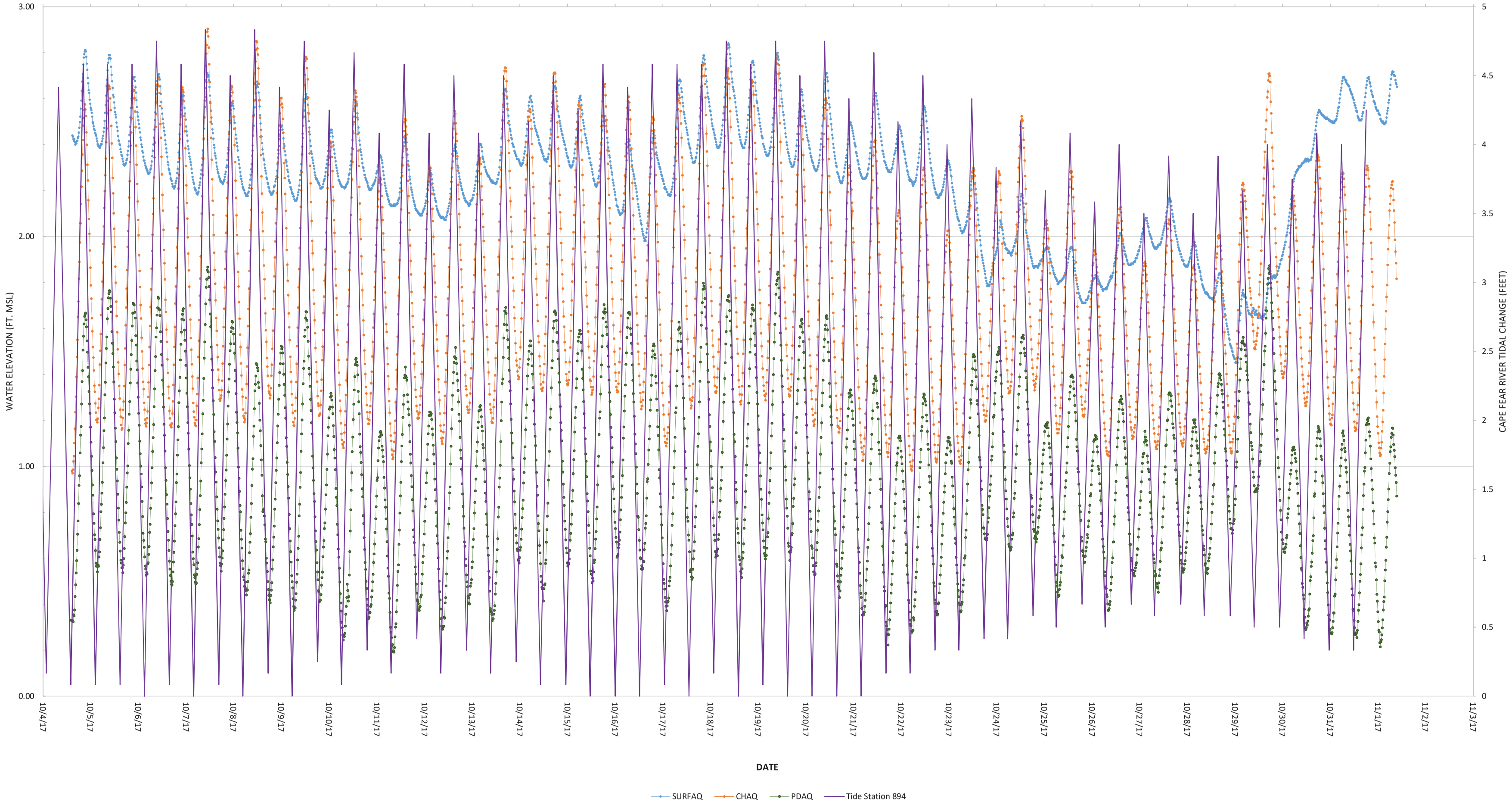
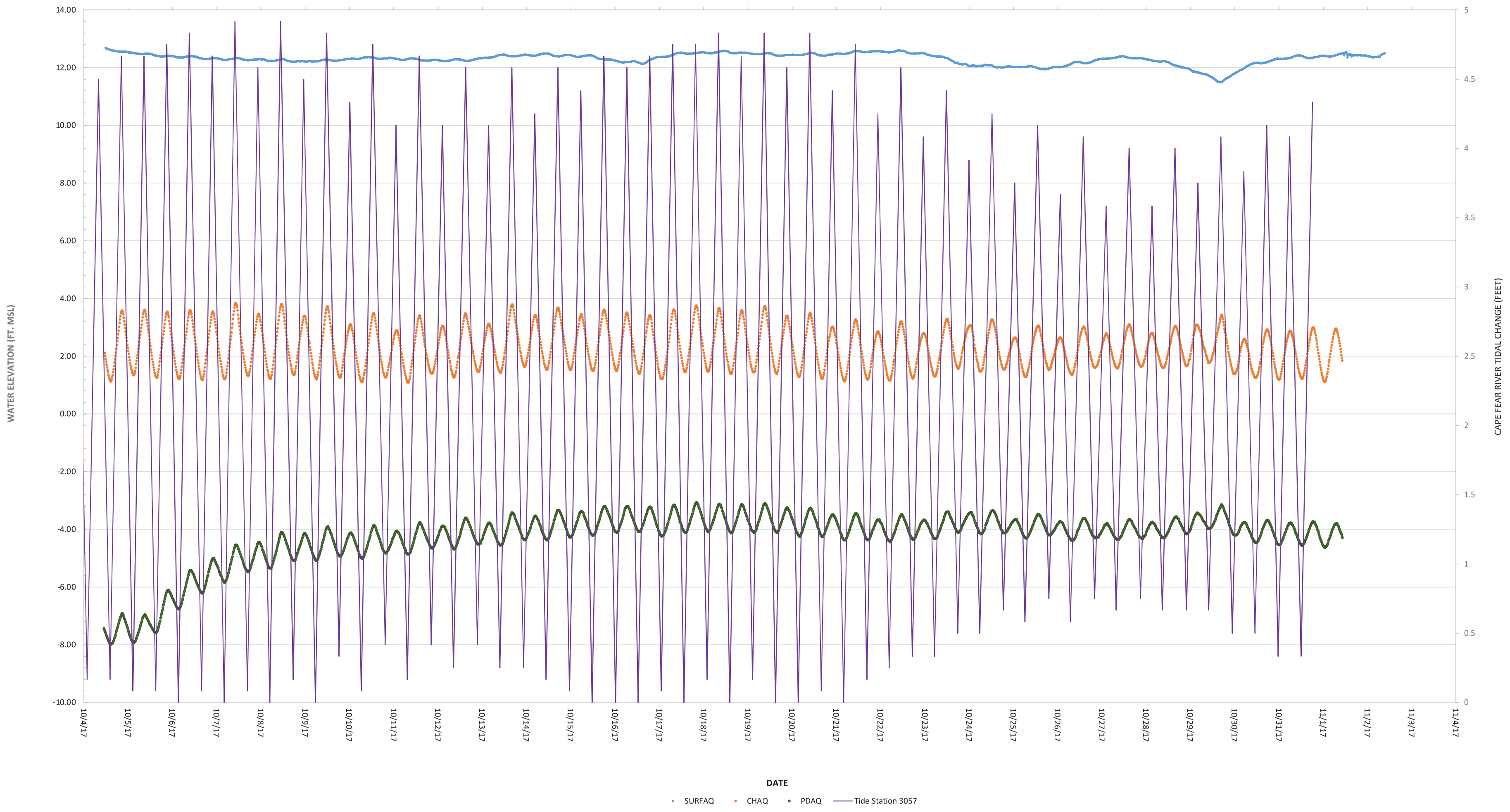


Figure 16. Water-Level Monitoring Data from Site #3 - Southport



Tables

Table 1. Hydrostratigraphic Units in New Hanover and Eastern Brunswick Counties

GEOLOGIC UNITS			HYDROGEOLOGIC UNITS
SYSTEM	SERIES	FORMATION	AQUIFERS AND CONFINING UNITS
Quarternary	Holocene	Surficial sand deposits	Surficial Aquifer
	Pleistocene	Undifferentiated Pleistocene and Pliocene deposits	
Tertiary	Pliocene		Tertiary Aquifer and Confining Unit
	Oligocene	River Bend Formation[1]	
			Castle Hayne Confining Unit
	Eocene	Castle Hayne Formation[2]	Castle Hayne Aquifer
	Paleocene	Beaufort Formation[3]	
			Peedee Confining Unit
Cretaceous	Upper Cretaceous	Peedee Formation	
			Peedee Aquifer
			Black Creek Confining Unit
		Black Creek and Middendorf Formations	
			Black Creek Aquifer
			Upper Cape Fear Confining Unit
		Cape Fear Formation	
			Upper Cape Fear Aquifer
			Lower Cape Fear Confining Unit
			Lower Cape Fear Aquifer
Pre-Cretaceous basement rocks			

[1] Presence limited to southern New Hanover County (Zarra, 1991).

[2] Presence limited to southern and eastern New Hanover County and southeastern Brunswick County (Zarra, 1991).

[3] Presence limited to southern New Hanover County and southeastern Brunswick County (Zarra, 1991).

Table 2. Summary of Well Construction Details of Monitoring Well Stations.

Station #	MW#	Latitude	Longitude	Total Depth (feet)	Casing Depth (feet)	Open Interval (feet)	Casing Stick-Up (feet)	TOC Elevation (feet)	Well Casing Diameter (inches)
1 - Front Street	**SAMW**	34.2172706°	-077.9511077°	10	0 - 5	5-10 (s)	3.1	6.84	2
	FLAMW	34.2172794°	-077.9510136°	35	0-25	25-35 (s)	2.9	6.8	2
	PDMW	34.2172889°	-077.9509344°	70	0-58	58-70 (oh)	3.25	6.96	6
2 - Fort Fisher	**SAMW**	33.9615080°	-077.9387461°	20	0-10	10-20 (s)	3.3	13.17	2
	CHAMW	33.9614691°	-077.9387017°	70	0-50	50-70 (s)	3.15	12.5	4
	PDAMW	33.9615677°	-077.9388061°	160	0-145	145-160 (s)	3.3	12.74	3
3 - Southport	**SAMW**	33.9474981°	-077.9855800°	20	0-5	5-20 (s)	3.2	26.92	2
	CHAMW	33.9475342°	-077.9855327°	90	0-60	60-90 (s)	2.95	27	4
	PDAMW	33.9475790°	-077.9854953°	150	0-130	130-150 (s)	3.1	27.36	4

(s) = Screen

(oh) = Open Hole

Casing Stick-Up is measured above land surface.

TOC Elevations are referenced to NAVD88

Table 3. - Aquifer Test Data Results - Monitoring Well Stations

Station #	MW#	Slug Test K (ft/day)	Pumping Test K (ft/day)
Site #1 - Front Street - Wilmington	SAMW	68	
	FLAMW		187
	PDMW		68
Site #2 - Fort Fisher Ferry	SAMW	28	
	CHAMW		35
	PDAMW		39
Site #3 - Southport	SAMW	1.5	
	CHAMW		126
	PDAMW		127.5

K = Hydraulic Conductivity

SAMW = Surficial Aquifer Monitoring Well

FLAMW = Fluvial Aquifer Monitoring Well

CHAMW = Castle Hayne Aquifer Monitoring Well

PDAMW = Peedee Aquifer Monitoring Well

Table 4. Water Quality Data Summary from Baseline Well Sampling – Monitoring Well Stations.

Station #	**MW#**	**Sample Date**	**Chloride (mg/L)**	**TDS (mg/L)**
Site #1 - Front Street - Wilmington	SAMW	11/14/2017	2350	3660
	FLAMW	11/14/2017	6	165
	PDMW	11/14/2017	17	239
Site #2 - Fort Fisher Ferry	SAMW	11/14/2017	876	2240
	CHAMW	9/1/2017	9440	22200
	PDAMW	8/31/2017	525	1220
Site #3 - Southport	SAMW	11/14/2017	14	2020
	CHAMW	4/25/2017	21	196
	PDAMW	4/26/2017	59	305

TDS = Total Dissolved Solids
mg/L = Milligrams per Liter
TDS at Southport Surficial Well is Elevated Due to a plume from the Archer Daniels Midland Gypsum Stack. This is not related to Saltwater Intrusion from the Cape Fear River.
SAMW = Surficial Aquifer Monitoring Well
FLAMW = Fluvial Aquifer Monitoring Well
CHAMW = Castle Hayne Aquifer Monitoring Well
PDAMW = Peedee Aquifer Monitoring Well

Table 5. Groundwater Level Measurements - Monitoring Well Stations.

Station #	MW#	Latitude	Longitude	TOC Elevation (ft)	9/14/2017 Static Water Level Depth (ft)	9/14/2017 Static Water Level Elevation (ft-msl)	10/4/2017 Static Water Level Depth (ft)	10/4/2017 Static Water Level Elevation (ft-msl)	11/1/2017 Static Water Level Depth (ft)	11/1/2017 Static Water Level Elevation (ft-msl)	11/14/2017 Static Water Level Depth (ft)	11/14/2017 Static Water Level Elevation (ft-msl)
Site #1 - Front Street - Wilmington	SAMW	34.2172706°	-077.9511077°	6.84	3.97	2.87	5.41	1.43	4.81	2.03	5.23	1.61
	FLAMW	34.2172794°	-077.9510136°	6.8	4.04	2.76	4.79	2.01	4.48	2.32	4.62	2.18
	PDMW	34.2172889°	-077.9509344°	6.96	4.27	2.69	5.07	1.89	4.64	2.32	4.85	2.11
Site #2 - Fort Fisher Ferry	SAMW	33.9615080°	-077.9387461°	13.17	9.78	3.39	10.73	2.44	10.29	2.88	10.63	2.54
	CHAMW	33.9614691°	-077.9387017°	12.5	11.06	1.44	11.52	0.98	10.8	1.7	NM	NM
	PDAMW	33.9615677°	-077.9388061°	12.74	12.22	0.52	12.41	0.33	11.8	0.94	NM	NM
Site #3 - Southport	SAMW	33.9474981°	-077.9855800°	26.92	14.25	12.67	14.23	12.69	14.75	12.17	14.87	12.05
	CHAMW	33.9475342°	-077.9855327°	27	25.47	1.53	24.89	2.11	25.64	1.36	NM	NM
	PDAMW	33.9475790°	-077.9854953°	27.36	31.43	-4.07	34.78	-7.42	31.84	-4.48	NM	NM

NM = Not Measured
SAMW = Surficial Aquifer Monitoring Well
FLAMW = Fluvial Aquifer Monitoring Well
CHAMW = Castle Hayne Aquifer Monitoring Well
PDAMW = Peedee Aquifer Monitoring Well

Appendix I

Well Permit Documents

GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

4300 Sapphire Court, Suite 100
Greenville, North Carolina 27834
Telephone 252-758-3310
www.gma-nc.com

June 7, 2017

Mr. Geoff Kegley
Hydrogeologist
North Carolina Division of Water Resources
Aquifer Protection Section
127 Cardinal Drive Extension
Wilmington, North Carolina 28405

Re: Monitoring Well Permit Application, Regional Groundwater Study of the New Hanover County/Brunswick County Area

Dear Mr. Kegley,

Groundwater Management Associates, Inc. (GMA) is working on a regional groundwater study project of the New Hanover County/Brunswick County area along the Cape Fear River. A part of our project will involve construction of monitoring wells intended to provide information about aquifer depths, water levels, and water quality along the Cape Fear River at up to three sites. Three monitoring wells are planned at each well site (a total of 9 wells).

Attached is a monitoring well construction permit application form to construct three monitoring wells at Site #1 located in Wilmington, NC. A monitoring well permit application for Site #2 will come at a later date, once the exact site is approved. Site #1 will include monitoring wells constructed in the Lower Peedee, Upper Peedee, and Surficial Aquifers. Approximate proposed well locations and depths will be as follows:

Site #1: S. Front Street, Wilmington, New Hanover Co.

Lower Peedee Aquifer Monitoring Well:	34.217172°, -77.951067°	Depth: 130 ft. BLS
Upper Peedee Aquifer Monitoring Well:	34.217181°, -77.951191°	Depth: 75 ft. BLS
Surficial Aquifer Monitoring Well:	34.217163°, -77.951327°	Depth: 15 ft. BLS

No known pollution or waste sources are associated with this site. Also, there are no known existing wells or test borings within 500 feet of the proposed wells.

Wells will be constructed of PVC casing and screens. Casings will be properly grouted to prevent interconnection of the aquifers. Proposed well construction diagrams, and maps detailing parcel information, and the well construction site layout are attached to each application form.

The wells are designed to monitor water levels and water quality of individual separate aquifers. Screened intervals will be selected based upon drilling observations and geophysical logs. Gravel pack intervals will not cross-connect different aquifers. The wells will be built according to the North Carolina

Well Construction Standards (NCAC 02C). Certified Well Contractors, Skipper's Well Drilling and Magette Well and Pump, will perform the drilling, well construction, and development of the monitoring wells.

We trust that the information provided herein is complete and will meet your requirements for issuing a well construction permit for building the six wells. If you have any questions, please contact Jay Holley or Kelley Smith at the address and phone number on our letterhead.

Best regards,

Groundwater Management Associates, Inc.

Kelley A. Smith

Kelley A. Smith, P.G.
Project Hydrogeologist

Enclosures:

- Monitoring Well Permit Application Forms
- Proposed Well Construction Diagrams
- Parcel Map
- Site Layout Map

CC: Todd Walton-NC Ports Authortiy

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF WATER RESOURCES

APPLICATION FOR PERMIT TO CONSTRUCT A MONITORING OR RECOVERY WELL SYSTEM

PLEASE TYPE OR PRINT CLEARLY

In accordance with the provisions of Article 7, Chapter 87, General Statutes of North Carolina and regulations pursuant thereto, application is hereby made for a permit to construct monitoring or recovery wells.

FOR OFFICE USE ONLY

PERMIT NO. ________________ ISSUED DATE ________________

1. Date: 6/6/2017

2. County: New Hanover

3. What type of well are you applying for? (monitoring or recovery): Monitoring

4. Applicant: Todd Walton-NC Ports Authority Telephone: 910-251-5678

Applicant's Mailing Address: PO Box 9002, Wilmington, NC 28402

Applicant's Email Address (if available): Todd.Walton@ncports.com

5. Contact Person (if different than Applicant): ________________ Telephone: ________________

Contact Person's Mailing Address: ________________

Contact Person's Email Address (if available): ________________

6. Property Owner (if different than Applicant): ________________ Telephone: ________________

Property Owner's Mailing Address: ________________

Property Owner's Email Address (if available): ________________

7. Property Physical Address (Including PIN Number) Parcel PID: R05320-001-001-000

City Wilmington County New Hanover Zip Code ________________

8. Reason for Well(s): Provide information about aquifer depths, water levels, and water quality along the Cape Fear River.
(ex: non-discharge permit requirements, suspected contamination, assessment, groundwater contamination, remediation, etc.)

9. Type of facility or site for which the well(s) is(are) needed: Vacant Land
(ex: non-discharge facility, waste disposal site, landfill, UST, etc.)

10. Are there any current water quality permits or incidents associated with this facility or site? If so, list permit and/or incident no(s).

NO

11. Type of contaminants being monitored or recovered: NA
(ex: organics, nutrients, heavy metals, etc.)

12. Are there any existing wells associated with the proposed well(s)? If yes, how many? NO

Existing Monitoring or Recovery Well Construction Permit No(s).: ________________

13. Distance from proposed well(s) to nearest known waste or pollution source (in feet): >500 ft.

14. Are there any water supply wells located less than 500 feet from the proposed well(s)? None known

If yes, give distance(s): ________________

15. Well Contractor: Charlie Skipper - Skipper's Well Drilling Certification No.: 2484

Well Contractor Address: 107 Oakland Avenue, Leland, NC 28451

PROPOSED WELL CONSTRUCTION INFORMATION

1. As required by 15A NCAC 02C .0105(f)(7), attach a well construction diagram of each well showing the following:

a. Borehole and well diameter
b. Estimated well depth
c. Screen intervals
d. Sand/gravel pack intervals
e. Type of casing material and thickness
f. Grout horizons
g. Well head completion details

Continued on Reverse

PROPOSED WELL CONSTRUCTION INFORMATION (Continued)

2. Number of wells to be constructed in unconsolidated material: 3

3. Number of wells to be constructed in bedrock: 0

4. Total Number of wells to be constructed: 3 (*add answers from 2 and 3*)

5. How will the well(s) be secured? Locking Above Ground Well Cover

6. Estimated beginning construction date: 6/19/2017

7. Estimated construction completion date: 6/23/2017

ADDITIONAL INFORMATION

1. As required by 15A NCAC 02C .0105(f)(5), attach a scaled map of the site showing the locations of the following:
   a. All property boundaries, at least one of which is referenced to a minimum of two landmarks such as identified roads, intersections, streams, or lakes within 500 feet of the proposed well or well system.
   b. All existing wells, identified by type of use, within 500 feet of the proposed well or well system.
   c. The proposed well or well system.
   d. Any test borings within 500 feet of proposed well or well system.
   e. All sources of known or potential groundwater contamination (such as septic tank systems, pesticide, chemical or fuel storage areas, animal feedlots as defined in G.S. 143-215.10B(5), landfills, or other waste disposal areas) within 500 feet of the proposed well or well system.

SIGNATURES

The Applicant hereby agrees that the proposed well(s) will be constructed in accordance with approved specifications and conditions of this Well Construction Permit as regulated under the Well Construction Standards (Title 15A of the North Carolina Administrative Code, Subchapter 2C) and accepts full responsibility for compliance with these rules

Todd C. Walt
Signature of Applicant or *Agent

SR. ENVIRONMENTAL ANALYST
Title of Applicant or *Agent

Todd C WALTON
Printed name of Applicant or *Agent

** If signing as Agent, attach authorization agreement stating that you have the authority to act as the Agent.*

If the property is owned by someone other than the applicant, the property owner hereby consents to allow the applicant to construct wells as outlined in this Well Construction Permit application and that it shall be the responsibility of the applicant to ensure that the well(s) conform to the Well Construction Standards (Title 15A of the North Carolina Administrative Code, Subchapter 2C).

Signature of Property Owner (if different than Applicant)

Printed name of Property Owner (if different than Applicant)

DIRECTIONS

Please send the completed application to the appropriate Division of Water Resources' Regional Office:

Asheville Regional Office
2090 U.S. Highway 70
Swannanoa, NC 28778
Phone: (828) 296-4500
Fax: (828) 299-7043

Fayetteville Regional Office
225 Green Street, Suite 714
Fayetteville, NC 28301-5094
Phone: (910) 433-3300
Fax: (910) 486-0707

Mooresville Regional Office
610 East Center Avenue
Mooresville, NC 28115
Phone: (704) 663-1699
Fax: (704) 663-6040

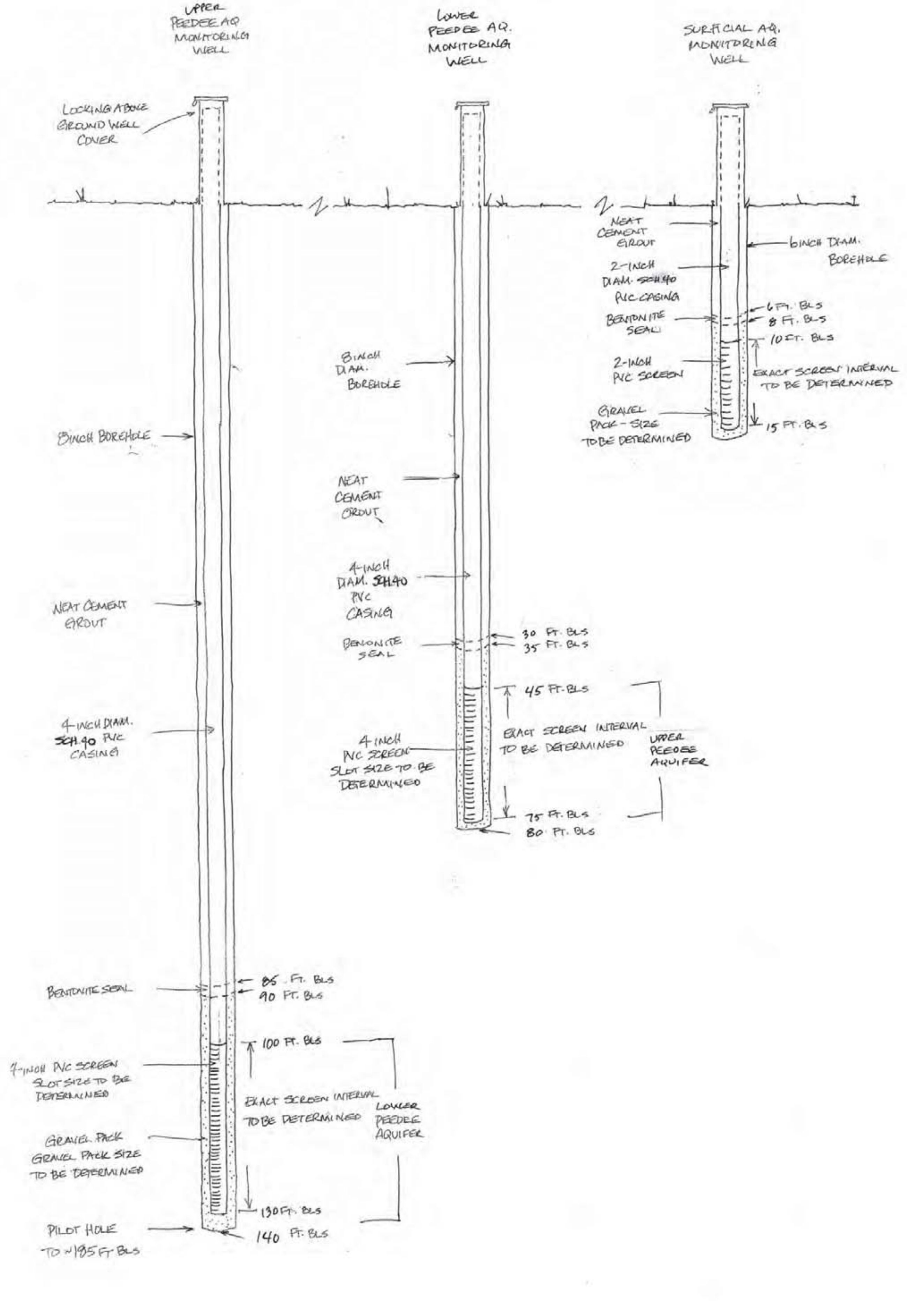
Raleigh Regional Office
3800 Barrett Drive
Raleigh, NC 27609
Phone: (919) 791-4200
Fax: (919) 571-4718

Washington Regional Office
943 Washington Square Mall
Washington, NC 27889
Phone: (252) 946-6481
Fax: (252) 975-3716

Wilmington Regional Office
127 Cardinal Drive Extension
Wilmington, NC 28405
Phone: (910) 796-7215
Fax: (910) 350-2004

Winston-Salem Regional Office
450 W. Hanes Mill Road
Suite 300
Winston-Salem, NC 27105
Phone: (336) 776-9800
Fax: (336) 776-9797

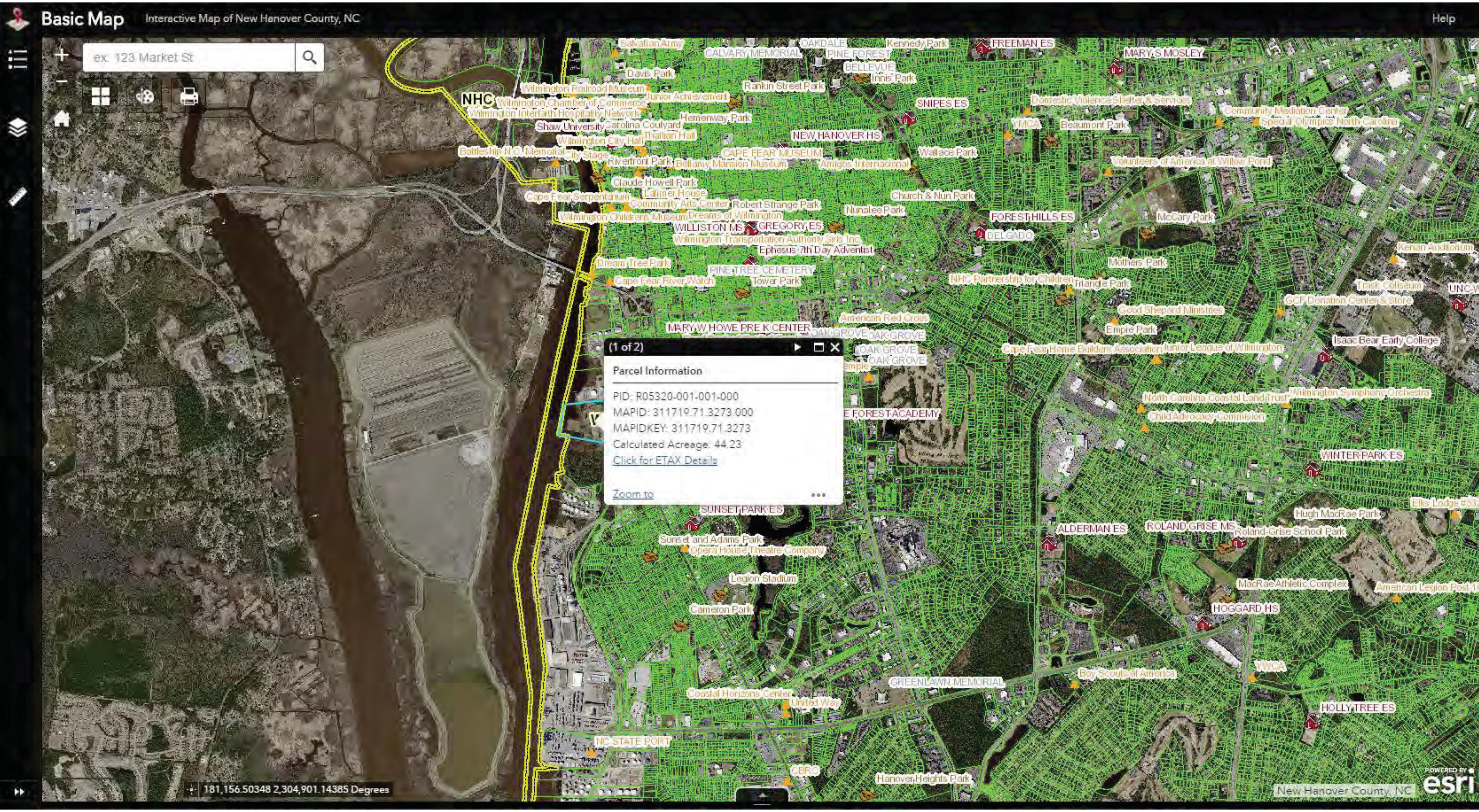
SITE: #1 - S. FRONT ST., WILMINGTON



NOT TO SCALE

Approx. MW Cluster Location

THE APPROXIMATE LOCATION OF THE MONITORING WELL CLUSTER - NC STATES PORT AUTHORITY, NEW HANOVER CO., NC

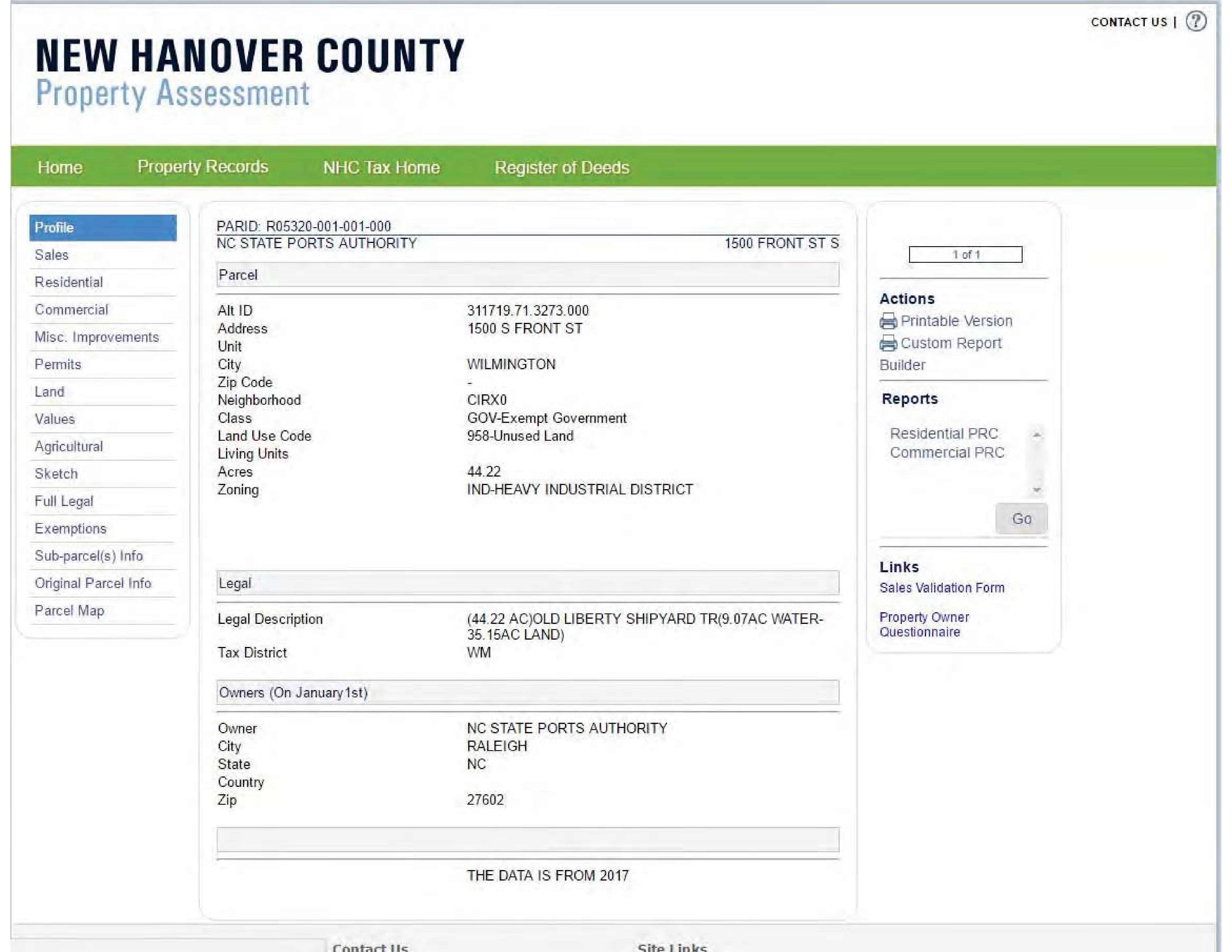


(1 of 2)

Parcel Information

PID: R05320-001-001-000
MAPID: 311719.71.3273.000
MAPIDKEY: 311719.71.3273
Calculated Acreage: 44.23
Click for ETAX Details

Zoom to



PARID: R05320-001-001-000

NC STATE PORTS AUTHORITY 1500 FRONT ST S

Parcel

Alt ID	311719.71.3273.000
Address	1500 S FRONT ST
Unit	
City	WILMINGTON
Zip Code	-
Neighborhood	CIRX0
Class	GOV-Exempt Government
Land Use Code	958-Unused Land
Living Units	
Acres	44.22
Zoning	IND-HEAVY INDUSTRIAL DISTRICT

Legal

Legal Description	(44.22 AC)OLD LIBERTY SHIPYARD TR(9.07AC WATER-35.15AC LAND)
Tax District	WM

Owners (On January1st)

Owner	NC STATE PORTS AUTHORITY
City	RALEIGH
State	NC
Country	
Zip	27602

THE DATA IS FROM 2017

NORTH CAROLINA
ENVIRONMENTAL MANAGEMENT COMMISSION
DEPARTMENT OF ENVIRONMENTAL QUALITY
RALEIGH, NORTH CAROLINA

PERMIT FOR THE CONSTRUCTION OF A WELL OR WELL SYSTEM

In accordance with the provisions of Article 7, Chapter 87, North Carolina General Statutes,
and other applicable Laws, Rules and Regulations

PERMISSION IS HEREBY GRANTED TO
NC Ports Authority

FOR THE CONSTRUCTION OF three (3) monitoring wells, which will be located on Shepard Road SE, Southport in Brunswick County, in accordance with the application received April 3, 2017 and in conformity with specifications and supporting data, all of which are filed with the Department of Environmental Quality and are considered part of the Permit.

This Permit is for well construction only and does not waive any provisions or requirements of the Water Use Act of 1967, or any other applicable laws and regulations. Well construction shall be in compliance with the North Carolina Well Construction Regulations and Standards. However, this Permit pertains to the jurisdictional authority of the Division of Water Resource and does not waive the requirements of other jurisdictions.

This Permit will be effective from the date of its issuance until April 5, 2018, and shall be subject to other specified conditions, limitations, or exceptions as follows:

1. The well(s) shall be located and constructed as shown on the attachments submitted as part of the permit application.
2. Well construction record (GW-1) for each well must be supplied to the Division of Water Resources' Information Processing Unit within 30 days of well completion. **Provide the well construction permit number on the GW-1 form.**
3. Issuance of this Permit does not obligate reimbursement from State trust funds, if these wells are being installed as part of an investigation for contamination from an underground storage tank or dry cleaner incident.
4. Issuance of this Permit does not supersede any other agreement, permit, or requirement issued by another agency.
5. The well(s) shall have a Well Contractor Identification Plate in accordance with 15A NCAC 02C.0108(o).
6. When the well(s) are discontinued or abandoned, they shall be abandoned in accordance with 15A NCAC 02C.0113 and a well abandonment record (GW-30) shall be submitted to the Division of Water Resource's Information Processing Unit within 30 days of well abandonment.

If any requirements or limitations of this Permit are unacceptable, you have the right to an adjudicatory hearing upon written request within 30 days. The request must be in the form of a written petition conforming to Chapter 150B of the North Carolina General Statutes and filed with the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, North Carolina 27699-6714. Unless such demand is made, this Permit is final and binding.

Permit issued this 5th day of April 2017

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

Jim Gregson, Regional Supervisor
Water Quality Regional Operations Section, Division of Water Resources
By Authority of the Environmental Management Commission

Cc: James Holley, P.G. and Kelley Smith, P.G. - Groundwater Management Associates, Inc. (via email)
NC DWR – WiRO (w/originals)

GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

4300 Sapphire Court, Suite 100
Greenville, North Carolina 27834
Telephone 252-758-3310
www.gma-nc.com

June 14, 2017

Mr. Geoff Kegley
Hydrogeologist
North Carolina Division of Water Resources
Aquifer Protection Section
127 Cardinal Drive Extension
Wilmington, North Carolina 28405

Re: Monitoring Well Permit Application, Regional Groundwater Study of the New Hanover County/Brunswick County Area

Dear Mr. Kegley,

Groundwater Management Associates, Inc. (GMA) is working on a regional groundwater study project of the New Hanover County/Brunswick County area along the Cape Fear River. A part of our project will involve construction of monitoring wells intended to provide information about aquifer depths, water levels, and water quality along the Cape Fear River at up to three sites. Three monitoring wells are planned at each well site (a total of 9 wells).

Attached is a monitoring well construction permit application form to construct three monitoring wells at Site #2 located in Kure Beach, NC. Monitoring well permits for Site #1 and #3 have been issued. Site #2 will include monitoring wells constructed in the Peedee, Castle Hayne, and Surficial Aquifers. Approximate proposed well locations and depths will be as follows:

Site #2: Ft. Fisher Ferry Terminal, Kure Beach, New Hanover Co.

Peedee Aquifer Monitoring Well:	33.961258°, - 77.938882°	Depth: 160 ft. BLS
Castle Hayne Aquifer Monitoring Well:	33.961309°, - 77.938930°	Depth: 115 ft. BLS
Surficial Aquifer Monitoring Well:	33.961348°, - 77.938970°	Depth: 20 ft. BLS

No known pollution or waste sources are associated with this site. Also, there are no known existing wells or test borings within 500 feet of the proposed wells.

Wells will be constructed of PVC casing and screens. Casings will be properly grouted to prevent interconnection of the aquifers. Proposed well construction diagrams, and maps detailing parcel information, and the well construction site layout are attached to each application form.

The wells are designed to monitor water levels and water quality of individual separate aquifers. Screened intervals will be selected based upon drilling observations and geophysical logs. Gravel pack intervals will not cross-connect different aquifers. The wells will be built according to the North Carolina

Well Construction Standards (NCAC 02C). Certified Well Contractors, Skipper’s Well Drilling and Magette Well and Pump, will perform the drilling, well construction, and development of the monitoring wells.

We trust that the information provided herein is complete and will meet your requirements for issuing a well construction permit for building the three wells. If you have any questions, please contact Jay Holley or Kelley Smith at the address and phone number on our letterhead.

Best regards,

Groundwater Management Associates, Inc.

Kelley A. Smith

Kelley A. Smith, P.G.
Project Hydrogeologist

Enclosures:
- Monitoring Well Permit Application Forms
- Proposed Well Construction Diagrams
- Parcel Map
- Site Layout Map

CC: Todd Walton-NC Ports Authortiy

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF WATER RESOURCES
APPLICATION FOR PERMIT TO CONSTRUCT A MONITORING OR RECOVERY WELL SYSTEM

PLEASE TYPE OR PRINT CLEARLY

In accordance with the provisions of Article 7, Chapter 87, General Statutes of North Carolina and regulations pursuant thereto, application is hereby made for a permit to construct monitoring or recovery wells.

FOR OFFICE USE ONLY
PERMIT NO. ______ ISSUED DATE ______

1. Date: 6/7/2017
2. County: New Hanover
3. What type of well are you applying for? (monitoring or recovery): Monitoring
4. Applicant: Todd Walton-NC Ports Authority Telephone: 910-251-5678

Applicant's Mailing Address: PO Box 9002, Wilmington, NC 28402

Applicant's Email Address (if available): Todd.Walton@ncports.com

5. Contact Person (if different than Applicant): ______ Telephone: ______

Contact Person's Mailing Address: ______

Contact Person's Email Address (if available): ______

6. Property Owner (if different than Applicant): MOTSU Telephone: 910-458-8429

Property Owner's Mailing Address: SDAT-PW, 6280 SUNNY POINT RD, SOUTHPORT NC

Property Owner's Email Address (if available): MICHAEL.B.FULLER.CIV@MAIL.MIL 28461

7. Property Physical Address (Including PIN Number) 2422 Fort Fisher Blvd S (Parcel PID: R09100-002-001-000)

City Kure Beach County New Hanover Zip Code 28449

8. Reason for Well(s): Provide information about aquifer depths, water levels, and water quality along the Cape Fear River.
(ex: non-discharge permit requirements, suspected contamination, assessment, groundwater contamination, remediation, etc.)
9. Type of facility or site for which the well(s) is(are) needed: DOT Ferry Terminal
(ex: non-discharge facility, waste disposal site, landfill, UST, etc.)
10. Are there any current water quality permits or incidents associated with this facility or site? If so, list permit and/or incident no(s).

NO

11. Type of contaminants being monitored or recovered: NA
(ex: organics, nutrients, heavy metals, etc.)
12. Are there any existing wells associated with the proposed well(s)? If yes, how many? NO

Existing Monitoring or Recovery Well Construction Permit No(s).: ______

13. Distance from proposed well(s) to nearest known waste or pollution source (in feet): NA
14. Are there any water supply wells located less than 500 feet from the proposed well(s)? None known

If yes, give distance(s): ______

15. Well Contractor: Bill Magette-Magette Well & Pump Certification No.: 2299

Well Contractor Address: 2342 US-13, Ahoskie, NC 27910

PROPOSED WELL CONSTRUCTION INFORMATION

1. As required by 15A NCAC 02C .0105(f)(7), attach a well construction diagram of each well showing the following:
   - a. Borehole and well diameter
   - b. Estimated well depth
   - c. Screen intervals
   - d. Sand/gravel pack intervals
   - e. Type of casing material and thickness
   - f. Grout horizons
   - g. Well head completion details

Continued on Reverse

PROPOSED WELL CONSTRUCTION INFORMATION (Continued)

2. Number of wells to be constructed in unconsolidated material: 3

3. Number of wells to be constructed in bedrock: 0

4. Total Number of wells to be constructed: 3 (*add answers from 2 and 3*)

5. How will the well(s) be secured? Locking Above Ground Well Cover

6. Estimated beginning construction date: 6/26/2017

7. Estimated construction completion date: 6/30/2017

ADDITIONAL INFORMATION

1. As required by 15A NCAC 02C .0105(f)(5), attach a scaled map of the site showing the locations of the following:

   a. All property boundaries, at least one of which is referenced to a minimum of two landmarks such as identified roads, intersections, streams, or lakes within 500 feet of the proposed well or well system.
   b. All existing wells, identified by type of use, within 500 feet of the proposed well or well system.
   c. The proposed well or well system.
   d. Any test borings within 500 feet of proposed well or well system.
   e. All sources of known or potential groundwater contamination (such as septic tank systems, pesticide, chemical or fuel storage areas, animal feedlots as defined in G.S. 143-215.10B(5), landfills, or other waste disposal areas) within 500 feet of the proposed well or well system.

SIGNATURES

The Applicant hereby agrees that the proposed well(s) will be constructed in accordance with approved specifications and conditions of this Well Construction Permit as regulated under the Well Construction Standards (Title 15A of the North Carolina Administrative Code, Subchapter 2C) and accepts full responsibility for compliance with these rules

Signature of Applicant or *Agent

SR. ENVIRONMENTAL ANALYST
Title of Applicant or *Agent

TODD C WALTON
Printed name of Applicant or *Agent

** If signing as Agent, attach authorization agreement stating that you have the authority to act as the Agent.*

If the property is owned by someone other than the applicant, the property owner hereby consents to allow the applicant to construct wells as outlined in this Well Construction Permit application and that it shall be the responsibility of the applicant to ensure that the well(s) conform to the Well Construction Standards (Title 15A of the North Carolina Administrative Code, Subchapter 2C).

Signature of Property Owner (if different than Applicant)

Matthew C. Swanson, MOTSU DFW
Printed name of Property Owner (if different than Applicant)

DIRECTIONS

Please send the completed application to the appropriate Division of Water Resources' Regional Office:

Asheville Regional Office
2090 U.S. Highway 70
Swannanoa, NC 28778
Phone: (828) 296-4500
Fax: (828) 299-7043

Fayetteville Regional Office
225 Green Street, Suite 714
Fayetteville, NC 28301-5094
Phone: (910) 433-3300
Fax: (910) 486-0707

Mooresville Regional Office
610 East Center Avenue
Mooresville, NC 28115
Phone: (704) 663-1699
Fax: (704) 663-6040

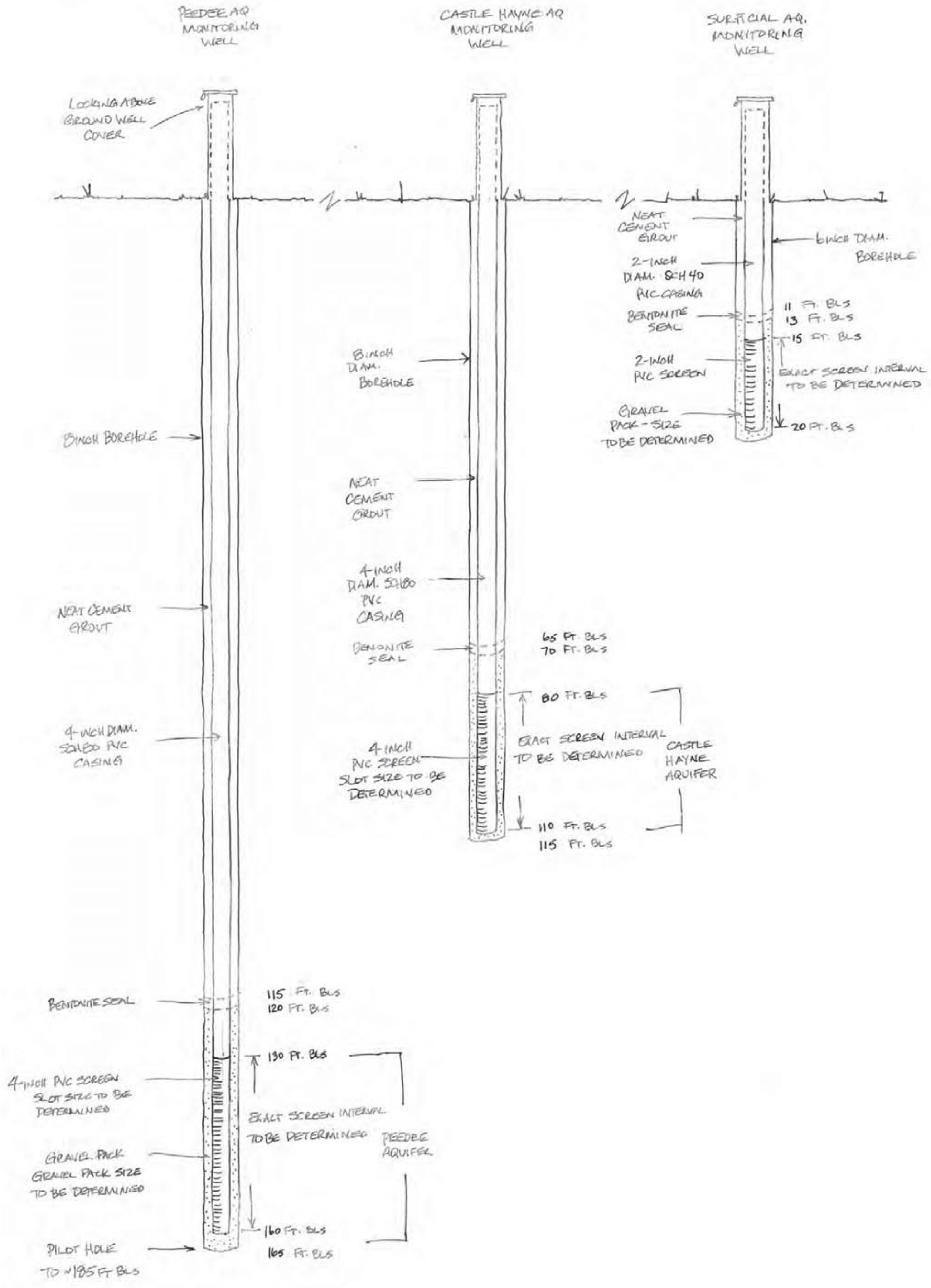
Raleigh Regional Office
3800 Barrett Drive
Raleigh, NC 27609
Phone: (919) 791-4200
Fax: (919) 571-4718

Washington Regional Office
943 Washington Square Mall
Washington, NC 27889
Phone: (252) 946-6481
Fax: (252) 975-3716

Wilmington Regional Office
127 Cardinal Drive Extension
Wilmington, NC 28405
Phone: (910) 796-7215
Fax: (910) 350-2004

Winston-Salem Regional Office
450 W. Hanes Mill Road
Suite 300
Winston-Salem, NC 27105
Phone: (336) 776-9800
Fax: (336) 776-9797

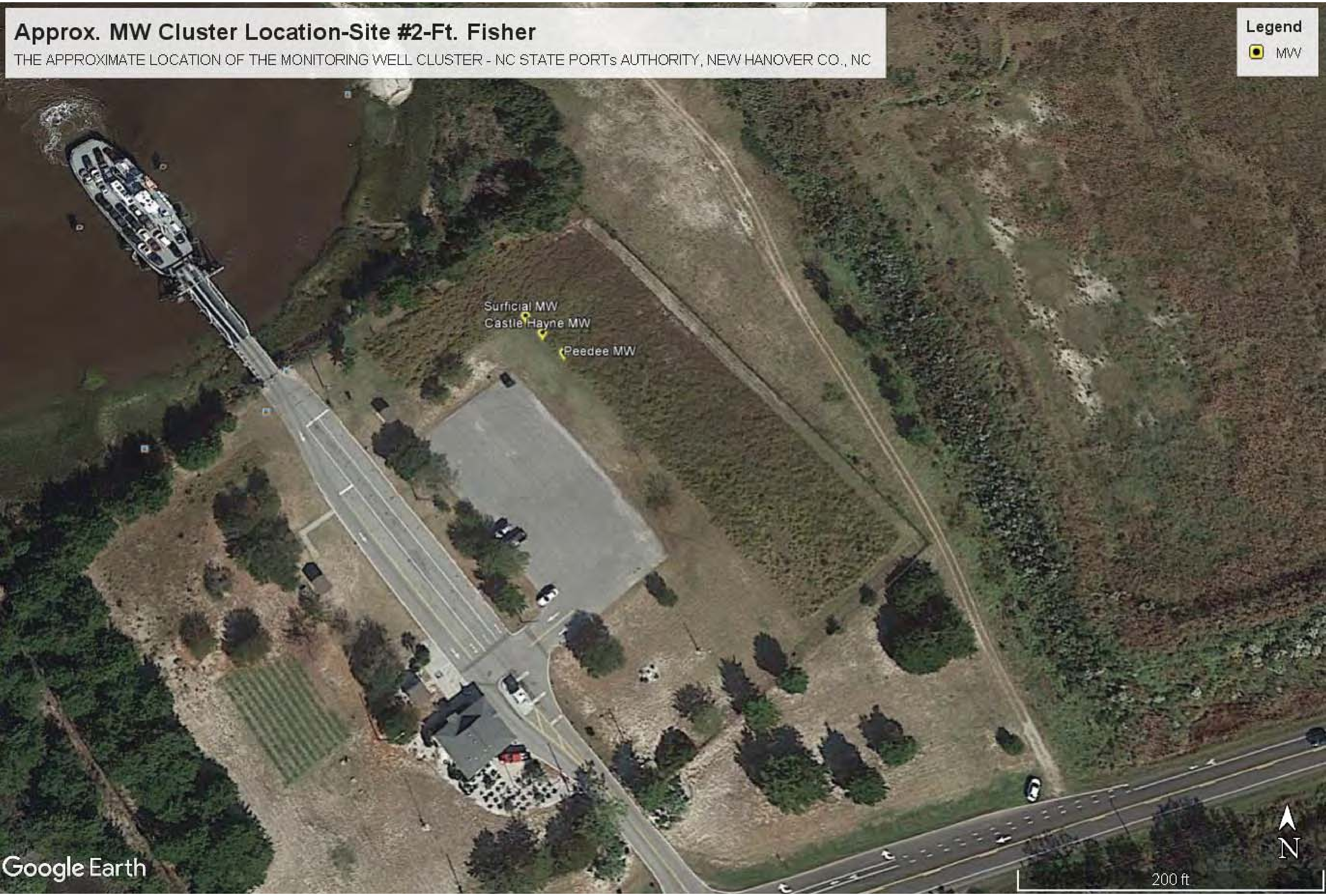
SITE: #2 - FT. FISHER

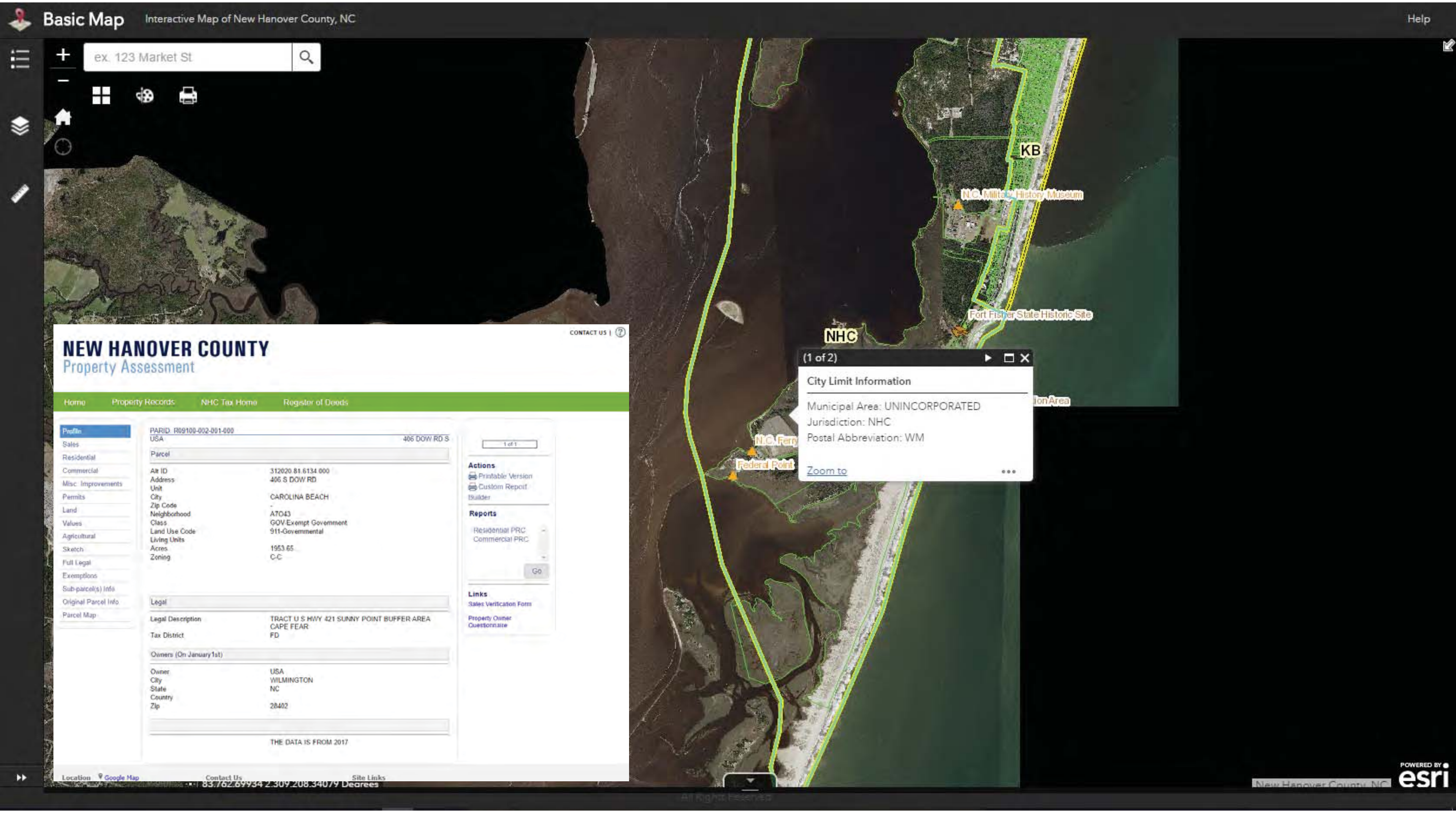


NOT TO SCALE

Approx. MW Cluster Location-Site #2-Ft. Fisher

THE APPROXIMATE LOCATION OF THE MONITORING WELL CLUSTER - NC STATE PORTs AUTHORITY, NEW HANOVER CO., NC





(1 of 2)

City Limit Information

Municipal Area: UNINCORPORATED
Jurisdiction: NHC
Postal Abbreviation: WM

Zoom to

NEW HANOVER COUNTY
Property Assessment

CONTACT US | ?

Home | Property Records | NHC Tax Home | Register of Deeds

Profile
Sales
Residential
Commercial
Misc. Improvements
Permits
Land
Values
Agricultural
Sketch
Full Legal
Exemptions
Sub-parcel(s) Info
Original Parcel Info
Parcel Map

PARID: R09100-002-001-000
USA — 406 DOW RD S

Parcel

Alt ID	312020.81.6134.000
Address	406 S DOW RD
Unit	
City	CAROLINA BEACH
Zip Code	-
Neighborhood	A7043
Class	GOV-Exempt Government
Land Use Code	911-Governmental
Living Units	
Acres	1953.65
Zoning	C-C

Legal

Legal Description	TRACT U S HWY 421 SUNNY POINT BUFFER AREA CAPE FEAR
Tax District	FD

Owners (On January 1st)

Owner	USA
City	WILMINGTON
State	NC
Country	
Zip	28402

THE DATA IS FROM 2017

1 of 1

Actions
Printable Version
Custom Report Builder

Reports
Residential PRC
Commercial PRC
Go

Links
Sales Verification Form
Property Owner Questionnaire

Location | Google Map | Contact Us | Site Links

PERMIT NO. WM0801094

NORTH CAROLINA
ENVIRONMENTAL MANAGEMENT COMMISSION
DEPARTMENT OF ENVIRONMENTAL QUALITY
RALEIGH, NORTH CAROLINA

PERMIT FOR THE CONSTRUCTION OF A WELL OR WELL SYSTEM

In accordance with the provisions of Article 7, Chapter 87, North Carolina General Statutes,
and other applicable Laws, Rules and Regulations

PERMISSION IS HEREBY GRANTED TO
NC Ports Authority

FOR THE CONSTRUCTION OF three (3) monitoring wells, which will be located at 1500 South Front Street in Wilmington, New Hanover County, in accordance with the application received June 7, 2017 and in conformity with specifications and supporting data, all of which are filed with the Department of Environmental Quality and are considered part of the Permit.

This Permit is for well construction only and does not waive any provisions or requirements of the Water Use Act of 1967, or any other applicable laws and regulations. Well construction shall be in compliance with the North Carolina Well Construction Regulations and Standards. However, this Permit pertains to the jurisdictional authority of the Division of Water Resource and does not waive the requirements of other jurisdictions.

This Permit will be effective from the date of its issuance until June 12, 2018, and shall be subject to other specified conditions, limitations, or exceptions as follows:

1. The well(s) shall be located and constructed as shown on the attachments submitted as part of the permit application.
2. Well construction record (GW-1) for each well must be supplied to the Division of Water Resources' Information Processing Unit within 30 days of well completion. **Provide the well construction permit number on the GW-1 form.**
3. Issuance of this Permit does not obligate reimbursement from State trust funds, if these wells are being installed as part of an investigation for contamination from an underground storage tank or dry cleaner incident.
4. Issuance of this Permit does not supersede any other agreement, permit, or requirement issued by another agency.
5. The well(s) shall have a Well Contractor Identification Plate in accordance with 15A NCAC 02C.0108(o).
6. When the well(s) are discontinued or abandoned, they shall be abandoned in accordance with 15A NCAC 02C.0113 and a well abandonment record (GW-30) shall be submitted to the Division of Water Resource's Information Processing Unit within 30 days of well abandonment.

If any requirements or limitations of this Permit are unacceptable, you have the right to an adjudicatory hearing upon written request within 30 days. The request must be in the form of a written petition conforming to Chapter 150B of the North Carolina General Statutes and filed with the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, North Carolina 27699-6714. Unless such demand is made, this Permit is final and binding.

Permit issued this 12th day of June 2017

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

Jon H. Cooper

for. Morella Sanchez King, PhD, PE, Environmental Program Supervisor III
Water Quality Regional Operations Section, Division of Water Resources
By Authority of the Environmental Management Commission

Cc: James Holley, P.G. and Kelley Smith, P.G. - Groundwater Management Associates, Inc. (via email)
NC DWR – WiRO (w/originals)

GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

4300 Sapphire Court, Suite 100
Greenville, North Carolina 27834
Telephone 252-758-3310
www.gma-nc.com

March 29, 2017

Mr. Geoff Kegley
Hydrogeologist
North Carolina Division of Water Resources
Aquifer Protection Section
127 Cardinal Drive Extension
Wilmington, North Carolina 28405

Re: Monitoring Well Permit Application, Regional Groundwater Study of the New Hanover County/Brunswick County Area

Dear Mr. Kegley,

Groundwater Management Associates, Inc. (GMA) is working with the North Carolina State Ports Authority on a regional groundwater study project of the New Hanover County/Brunswick County area along the Cape Fear River. A part of our project will involve construction of monitoring wells intended to provide information about aquifer depths, water levels, and water quality along the Cape Fear River at up to three separate well sites. Two proposed sites will occur in New Hanover County on the east side of the Cape Fear River. Site #3 is in Brunswick County on the west side of the Cape Fear River.

Attached is a monitoring well construction permit application form to construct three monitoring wells at Site #3 located near Southport, NC. Monitoring well permit applications for Site #1 and Site #2 will come at a later date, once the exact sites are chosen. Site #3 will include monitoring wells constructed in the Peedee, Castle Hayne, and Surficial Aquifers. Approximate proposed well locations and depths will be as follows:

Site #3: Shepard Road SE, Southport, Brunswick Co.

Peedee Aquifer Monitoring Well:	33.947602°, -77.985400°	Depth: 175 ft. BLS
Castle Hayne Aquifer Monitoring Well:	33.947537°, -77.985505°	Depth: 100 ft. BLS
Surficial Aquifer Monitoring Well:	33.947479°, -77.985618°	Depth: 15 ft. BLS

No known pollution or waste sources are located in the area. Also, there are no known existing wells or test borings within 500 feet of the proposed wells.

Wells will be constructed of PVC casing and screens. Casings will be properly grouted to prevent interconnection of the aquifers. Proposed well construction diagrams, maps detailing parcel information, and the well construction site layout are attached with this letter.

The wells are designed to monitor water levels and water quality of individual separate aquifers. Screened intervals will be selected based upon drilling observations and geophysical logs. Gravel pack intervals will not cross-connect different aquifers. The wells will be built according to the North Carolina

Well Construction Standards (NCAC 02C). A Certified Well Contractor from Skipper's Well Drilling will perform the drilling, well construction, and development of the monitoring wells.

We trust that the information provided herein is complete and will meet your requirements for issuing a well construction permit for building the three wells. If you have any questions, please contact Jay Holley or Kelley Smith at the address and phone number on our letterhead.

Best regards,

Groundwater Management Associates, Inc.

James K. Holley, P.G.
Senior Hydrogeologist

Enclosures:

Monitoring Well Permit Application Form
Proposed Well Construction Diagrams
Parcel Map
Site Layout Map

CC: Todd Walton-NC Ports Authority
Jeff Shelden – Moffatt & Nichol

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF WATER RESOURCES
APPLICATION FOR PERMIT TO CONSTRUCT A MONITORING OR RECOVERY WELL SYSTEM

PLEASE TYPE OR PRINT CLEARLY

In accordance with the provisions of Article 7, Chapter 87, General Statutes of North Carolina and regulations pursuant thereto, application is hereby made for a permit to construct monitoring or recovery wells.

FOR OFFICE USE ONLY

PERMIT NO. ______ ISSUED DATE ______

1. Date: 3/28/2017
2. County: Brunswick
3. What type of well are you applying for? (monitoring or recovery): Monitoring
4. Applicant: Todd Walton-NC Ports Authority Telephone: 910-251-5678

   Applicant's Mailing Address: PO Box 9002, Wilmington, NC 28402

   Applicant's Email Address (if available): Todd.Walton@ncports.com
5. Contact Person (if different than Applicant): ______ Telephone: ______

   Contact Person's Mailing Address: ______

   Contact Person's Email Address (if available): ______
6. Property Owner (if different than Applicant): ______ Telephone: ______

   Property Owner's Mailing Address: ______

   Property Owner's Email Address (if available): ______
7. Property Physical Address (Including PIN Number) Parcel PIN: 300700645484

   City Southport County Brunswick Zip Code ______
8. Reason for Well(s): Provide information about aquifer depths, water levels, and water quality along the Cape Fear River.
   (ex: non-discharge permit requirements, suspected contamination, assessment, groundwater contamination, remediation, etc.)
9. Type of facility or site for which the well(s) is(are) needed: Vacant Land
   (ex: non-discharge facility, waste disposal site, landfill, UST, etc.)
10. Are there any current water quality permits or incidents associated with this facility or site? If so, list permit and/or incident no(s).

    NO
11. Type of contaminants being monitored or recovered: NA
    (ex: organics, nutrients, heavy metals, etc.)
12. Are there any existing wells associated with the proposed well(s)? If yes, how many? NO

    Existing Monitoring or Recovery Well Construction Permit No(s).: ______
13. Distance from proposed well(s) to nearest known waste or pollution source (in feet): None known
14. Are there any water supply wells located less than 500 feet from the proposed well(s)? None known

    If yes, give distance(s): ______
15. Well Contractor: Charlie Skipper - Skipper's Well Drilling Certification No.: 2484

    Well Contractor Address: 107 Oakland Avenue, Leland, NC 28451

PROPOSED WELL CONSTRUCTION INFORMATION

1. As required by 15A NCAC 02C .0105(f)(7), attach a well construction diagram of each well showing the following:

   a. Borehole and well diameter
   b. Estimated well depth
   c. Screen intervals
   d. Sand/gravel pack intervals
   e. Type of casing material and thickness
   f. Grout horizons
   g. Well head completion details

Continued on Reverse

PROPOSED WELL CONSTRUCTION INFORMATION (Continued)

2. Number of wells to be constructed in unconsolidated material: 3
3. Number of wells to be constructed in bedrock: 0
4. Total Number of wells to be constructed: 3 (*add answers from 2 and 3*)
5. How will the well(s) be secured? Locking Above Ground Well Cover
6. Estimated beginning construction date: 4/3/2017
7. Estimated construction completion date: 5/3/2017

ADDITIONAL INFORMATION

1. As required by 15A NCAC 02C .0105(f)(5), attach a scaled map of the site showing the locations of the following:
   a. All property boundaries, at least one of which is referenced to a minimum of two landmarks such as identified roads, intersections, streams, or lakes within 500 feet of the proposed well or well system.
   b. All existing wells, identified by type of use, within 500 feet of the proposed well or well system.
   c. The proposed well or well system.
   d. Any test borings within 500 feet of proposed well or well system.
   e. All sources of known or potential groundwater contamination (such as septic tank systems, pesticide, chemical or fuel storage areas, animal feedlots as defined in G.S. 143-215.10B(5), landfills, or other waste disposal areas) within 500 feet of the proposed well or well system.

SIGNATURES

The Applicant hereby agrees that the proposed well(s) will be constructed in accordance with approved specifications and conditions of this Well Construction Permit as regulated under the Well Construction Standards (Title 15A of the North Carolina Administrative Code, Subchapter 2C) and accepts full responsibility for compliance with these rules

James K Holley – GMA
Signature of Applicant or *Agent

HYDROGEOLOGIST
Title of Applicant or *Agent

James K. Holley – GMA
Printed name of Applicant or *Agent

** If signing as Agent, attach authorization agreement stating that you have the authority to act as the Agent.*

If the property is owned by someone other than the applicant, the property owner hereby consents to allow the applicant to construct wells as outlined in this Well Construction Permit application and that it shall be the responsibility of the applicant to ensure that the well(s) conform to the Well Construction Standards (Title 15A of the North Carolina Administrative Code, Subchapter 2C).

Signature of Property Owner (if different than Applicant)

TODD C. WALTON
Printed name of Property Owner (if different than Applicant)

DIRECTIONS

Please send the completed application to the appropriate Division of Water Resources' Regional Office:

Asheville Regional Office
2090 U.S. Highway 70
Swannanoa, NC 28778
Phone: (828) 296-4500
Fax: (828) 299-7043

Fayetteville Regional Office
225 Green Street, Suite 714
Fayetteville, NC 28301-5094
Phone: (910) 433-3300
Fax: (910) 486-0707

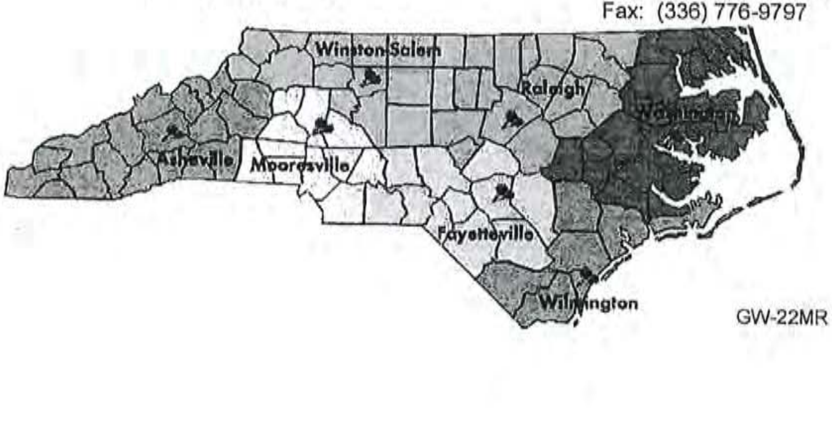
Mooresville Regional Office
610 East Center Avenue
Mooresville, NC 28115
Phone: (704) 663-1699
Fax: (704) 663-6040

Raleigh Regional Office
3800 Barrett Drive
Raleigh, NC 27609
Phone: (919) 791-4200
Fax: (919) 571-4718

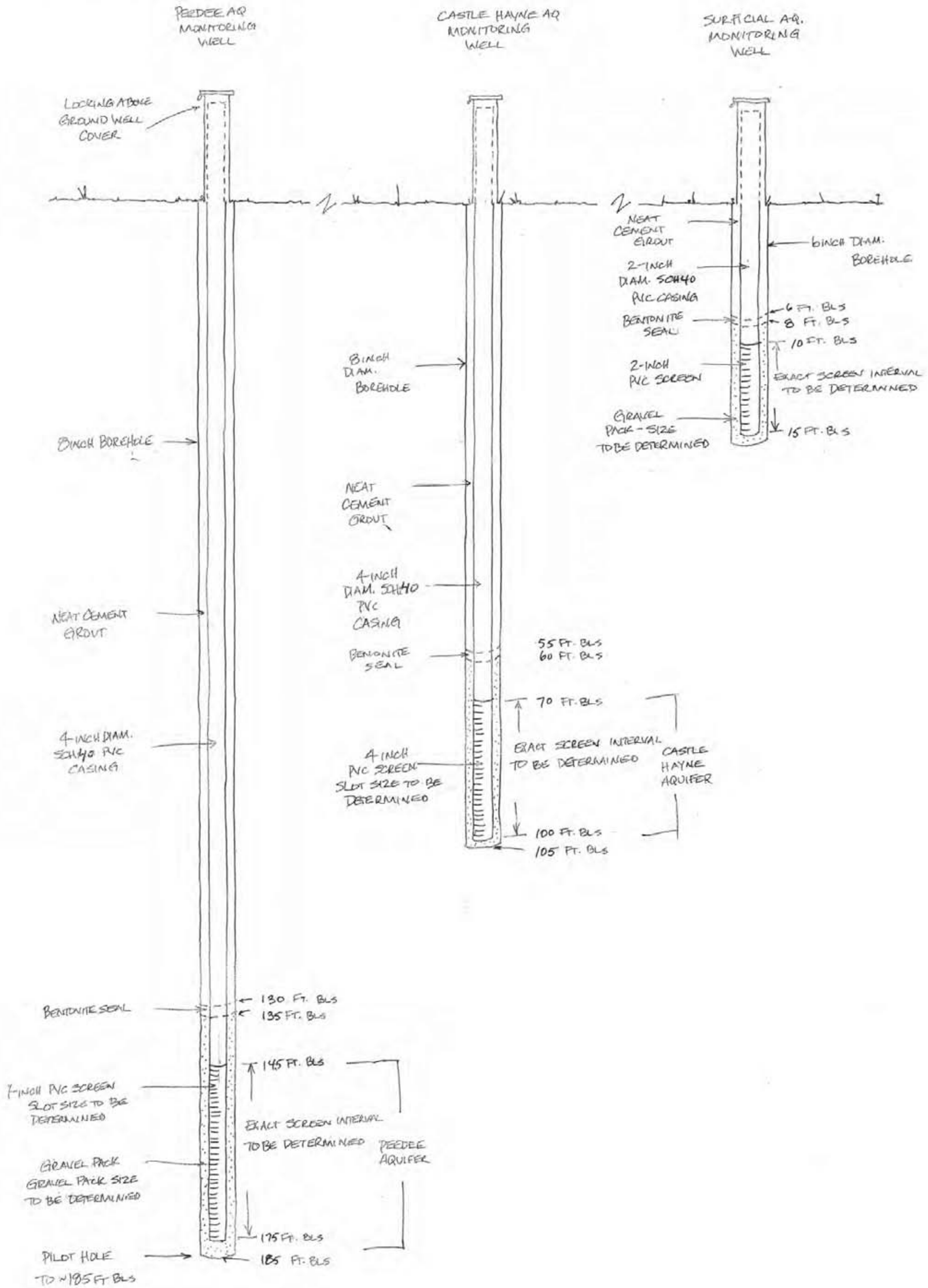
Washington Regional Office
943 Washington Square Mall
Washington, NC 27889
Phone: (252) 946-6481
Fax: (252) 975-3716

Wilmington Regional Office
127 Cardinal Drive Extension
Wilmington, NC 28405
Phone: (910) 796-7215
Fax: (910) 350-2004

Winston-Salem Regional Office
450 W. Hanes Mill Road
Suite 300
Winston-Salem, NC 27105
Phone: (336) 776-9800
Fax: (336) 776-9797

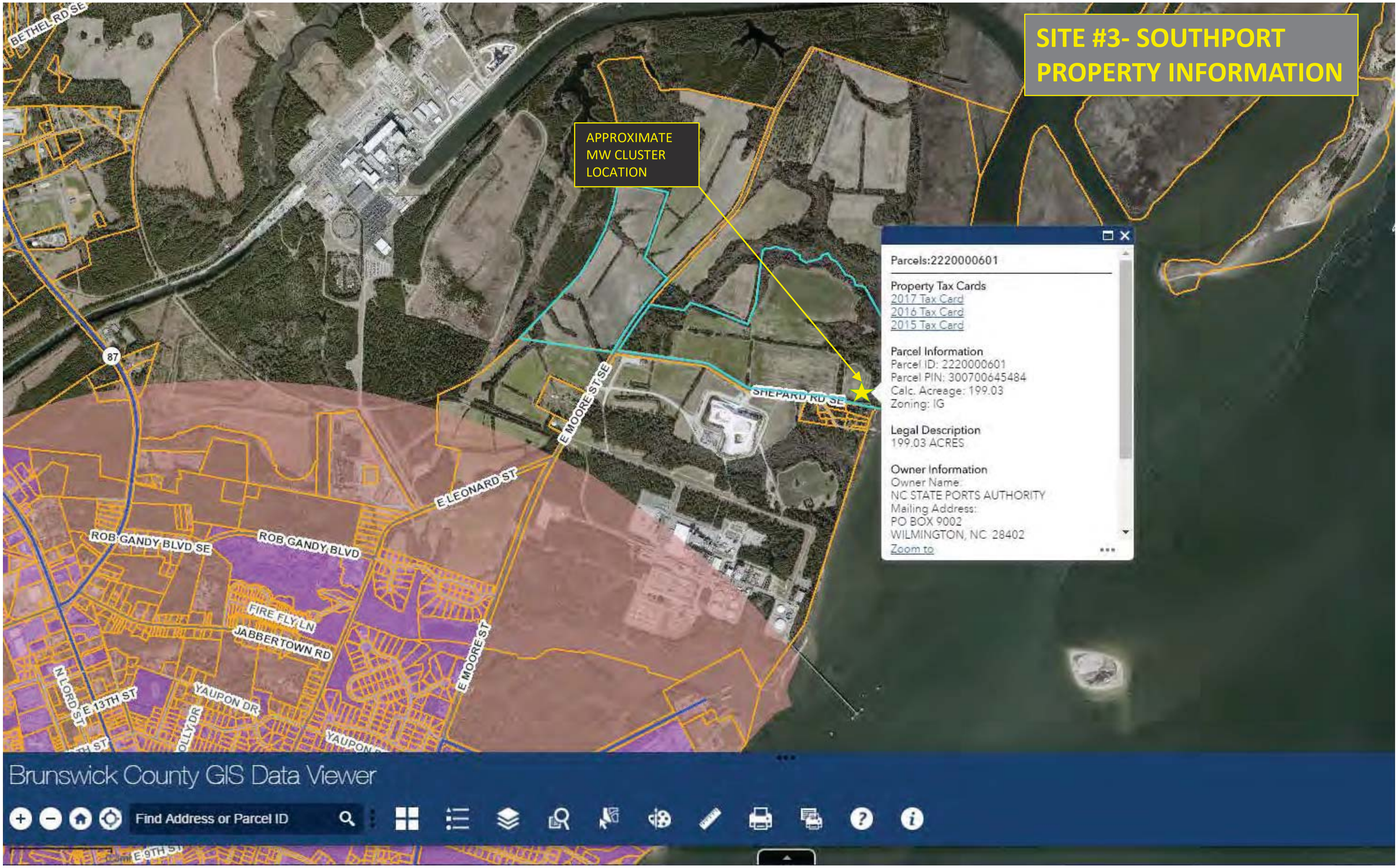


SITE: #3 - SOUTHPORT



NOT TO SCALE

SITE #3- SOUTHPORT PROPERTY INFORMATION



Parcels:2220000601

Property Tax Cards
2017 Tax Card
2016 Tax Card
2015 Tax Card

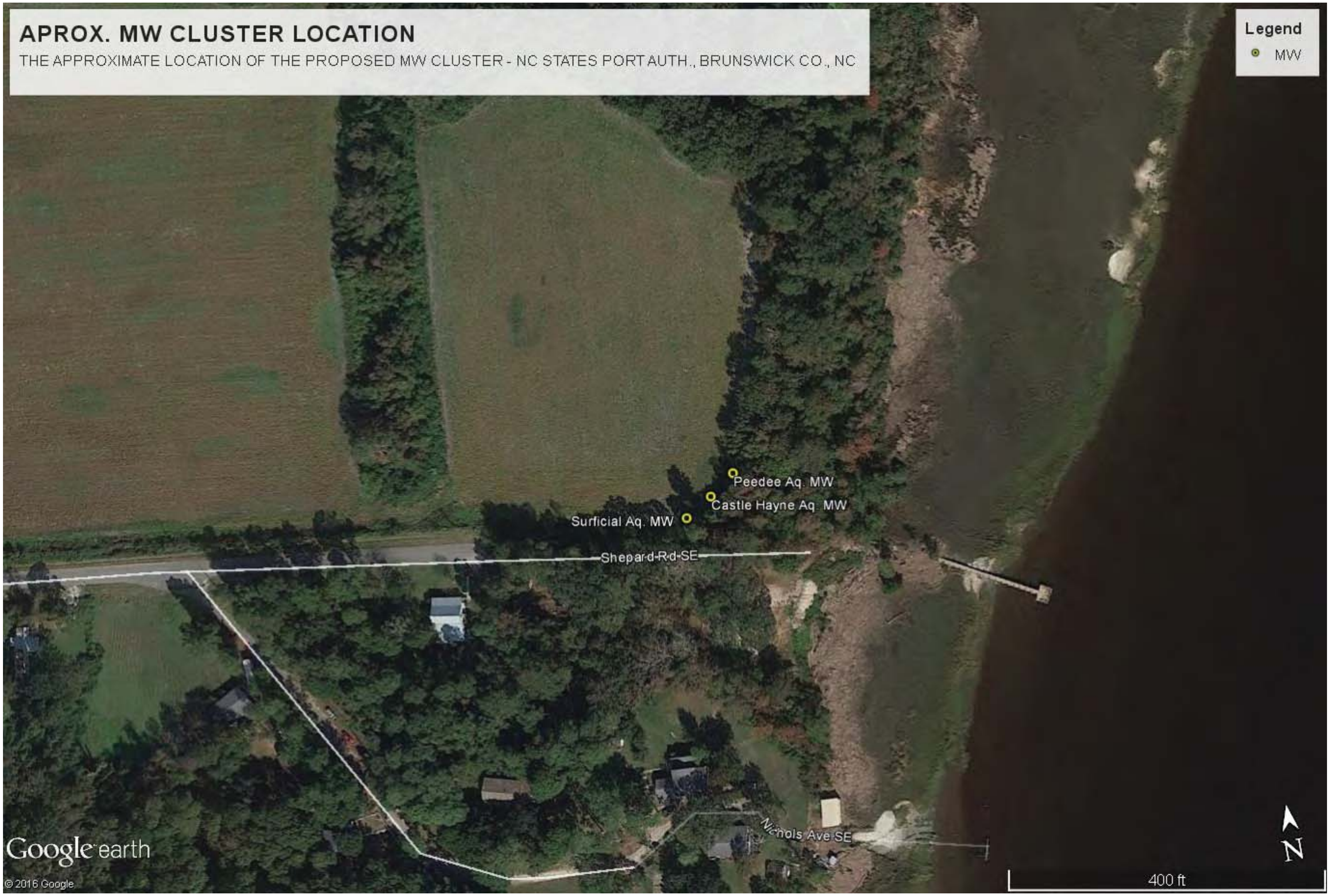
Parcel Information
Parcel ID: 2220000601
Parcel PIN: 300700645484
Calc. Acreage: 199.03
Zoning: IG

Legal Description
199.03 ACRES

Owner Information
Owner Name:
NC STATE PORTS AUTHORITY
Mailing Address:
PO BOX 9002
WILMINGTON, NC 28402
Zoom to

APROX. MW CLUSTER LOCATION

THE APPROXIMATE LOCATION OF THE PROPOSED MW CLUSTER - NC STATES PORT AUTH., BRUNSWICK CO., NC



NORTH CAROLINA
ENVIRONMENTAL MANAGEMENT COMMISSION
DEPARTMENT OF ENVIRONMENTAL QUALITY
RALEIGH, NORTH CAROLINA

PERMIT FOR THE CONSTRUCTION OF A WELL OR WELL SYSTEM

In accordance with the provisions of Article 7, Chapter 87, North Carolina General Statutes, and other applicable Laws, Rules and Regulations

PERMISSION IS HEREBY GRANTED TO
NC Ports Authority

FOR THE CONSTRUCTION OF three (3) monitoring wells, which will be located at 2422 Fort Fisher Blvd. S., Kure Beach, New Hanover County, in accordance with the application received June 14, 2017 and in conformity with specifications and supporting data, all of which are filed with the Department of Environmental Quality and are considered part of the Permit.

This Permit is for well construction only and does not waive any provisions or requirements of the Water Use Act of 1967, or any other applicable laws and regulations. Well construction shall be in compliance with the North Carolina Well Construction Regulations and Standards. However, this Permit pertains to the jurisdictional authority of the Division of Water Resource and does not waive the requirements of other jurisdictions.

This Permit will be effective from the date of its issuance until June 15, 2018, and shall be subject to other specified conditions, limitations, or exceptions as follows:

1. The well(s) shall be located and constructed as shown on the attachments submitted as part of the permit application.
2. Well construction record (GW-1) for each well must be supplied to the Division of Water Resources' Information Processing Unit within 30 days of well completion. **Provide the well construction permit number on the GW-1 form.**
3. Issuance of this Permit does not obligate reimbursement from State trust funds, if these wells are being installed as part of an investigation for contamination from an underground storage tank or dry cleaner incident.
4. Issuance of this Permit does not supersede any other agreement, permit, or requirement issued by another agency.
5. The well(s) shall have a Well Contractor Identification Plate in accordance with 15A NCAC 02C.0108(o).
6. When the well(s) are discontinued or abandoned, they shall be abandoned in accordance with 15A NCAC 02C.0113 and a well abandonment record (GW-30) shall be submitted to the Division of Water Resource's Information Processing Unit within 30 days of well abandonment.

If any requirements or limitations of this Permit are unacceptable, you have the right to an adjudicatory hearing upon written request within 30 days. The request must be in the form of a written petition conforming to Chapter 150B of the North Carolina General Statutes and filed with the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, North Carolina 27699-6714. Unless such demand is made, this Permit is final and binding.

Permit issued this 15th day of June 2017

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

Morella Sanchez King, PhD, PE, Environmental Program Supervisor III
Water Quality Regional Operations Section, Division of Water Resources
By Authority of the Environmental Management Commission

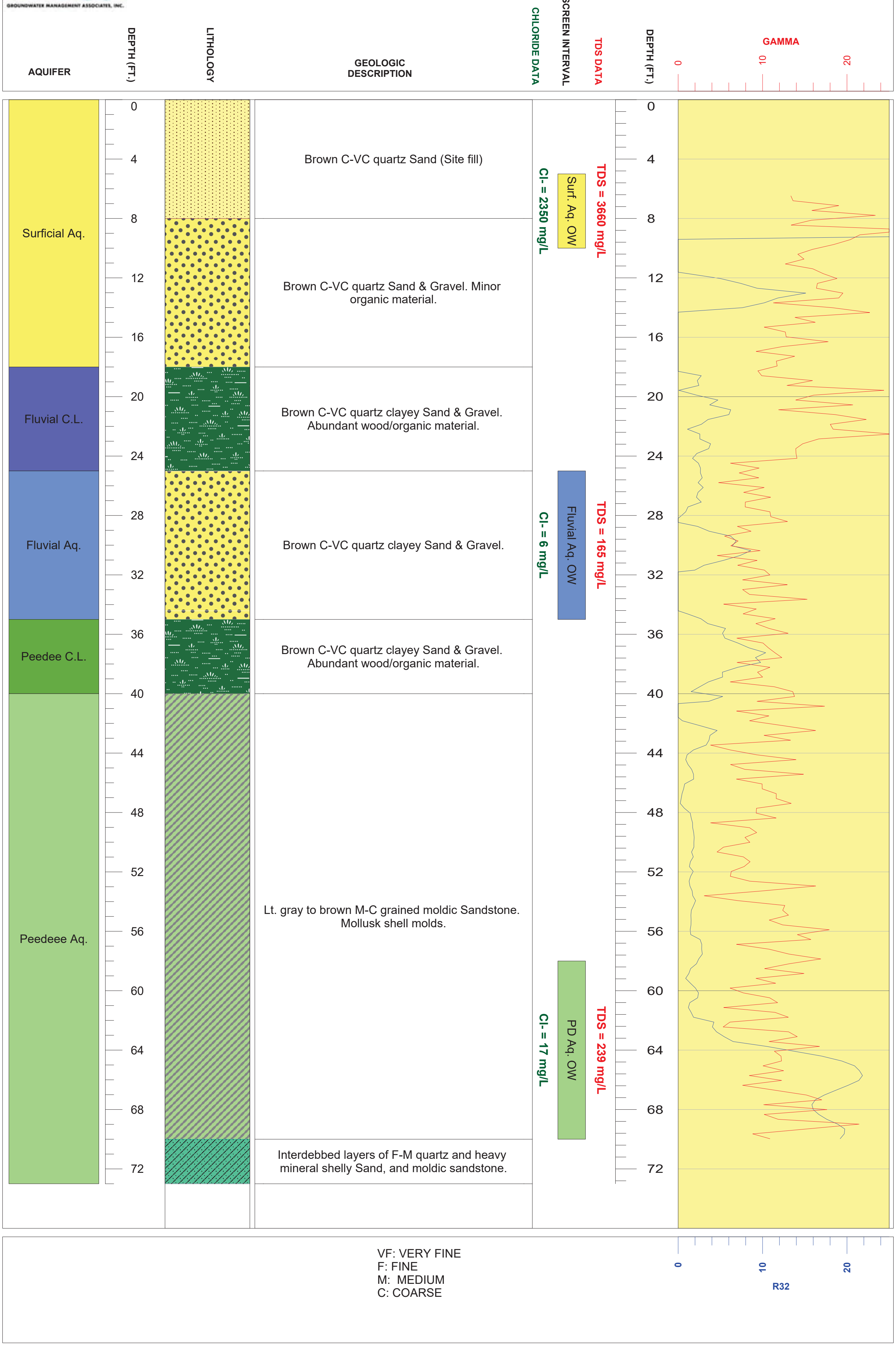
Cc: James Holley, P.G. and Kelley Smith, P.G. - Groundwater Management Associates, Inc. (via email)
NC DWR – WiRO (w/originals)

Appendix II

Well Construction Records, Geophysical Logs, and Site Photographs

SITE #1-FRONT ST., WILMINGTON OW'S

GMA Project #: 160001
FRONT ST., WILMINGTON, NEW HANOVER COUNTY, NORTH CAROLINA
Approx. Pilot Hole Location: N 34.217173°, W 77.951246°



Date: Tuesday, June 27, 2017 Time: 14:46 File: C:\My Documents\skipper\gma state port site 1 wilm..rd

MSI

CO
WELL
FLD
CTY
STE
FILING No

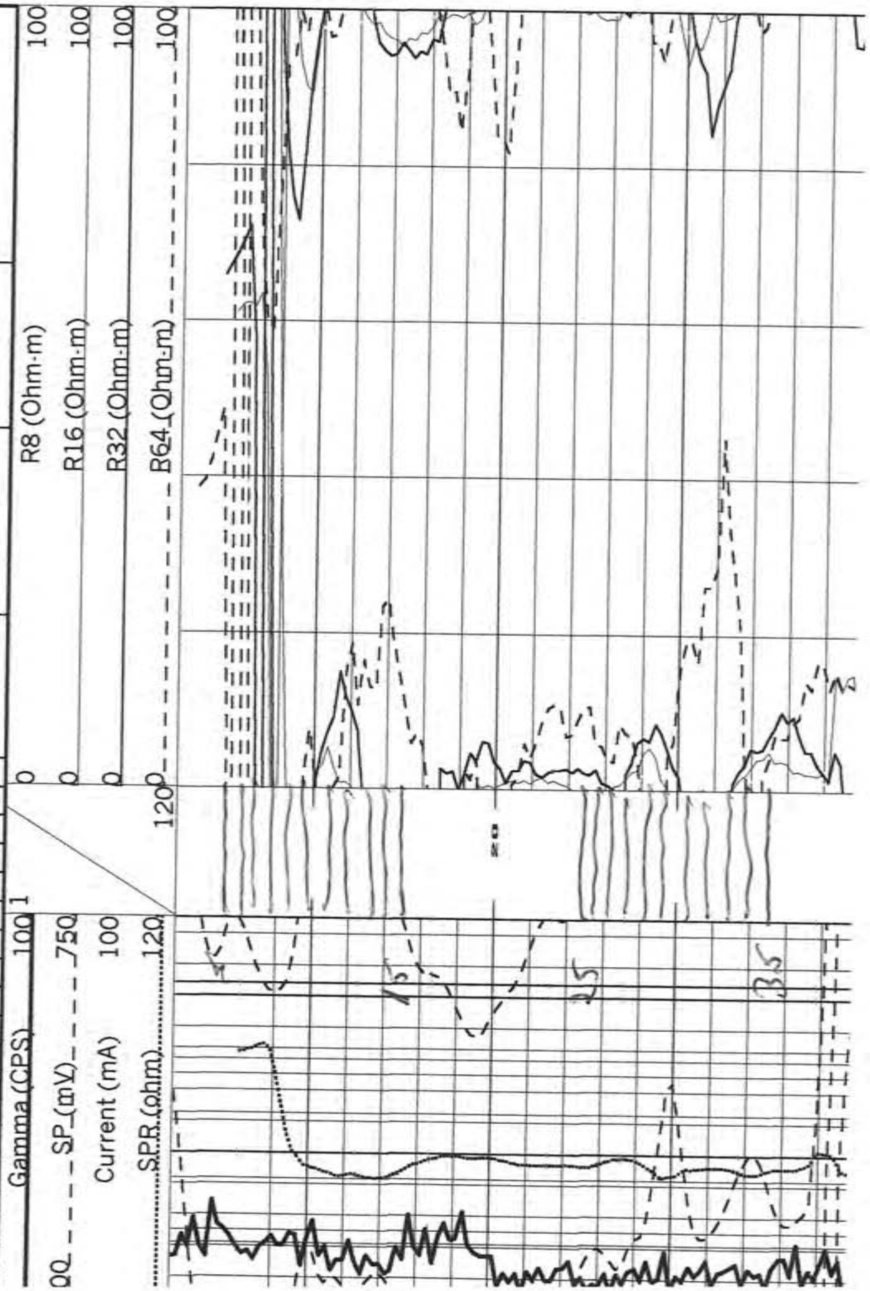
COMPANY
WELL ID
FIELD
COUNTRY STATE

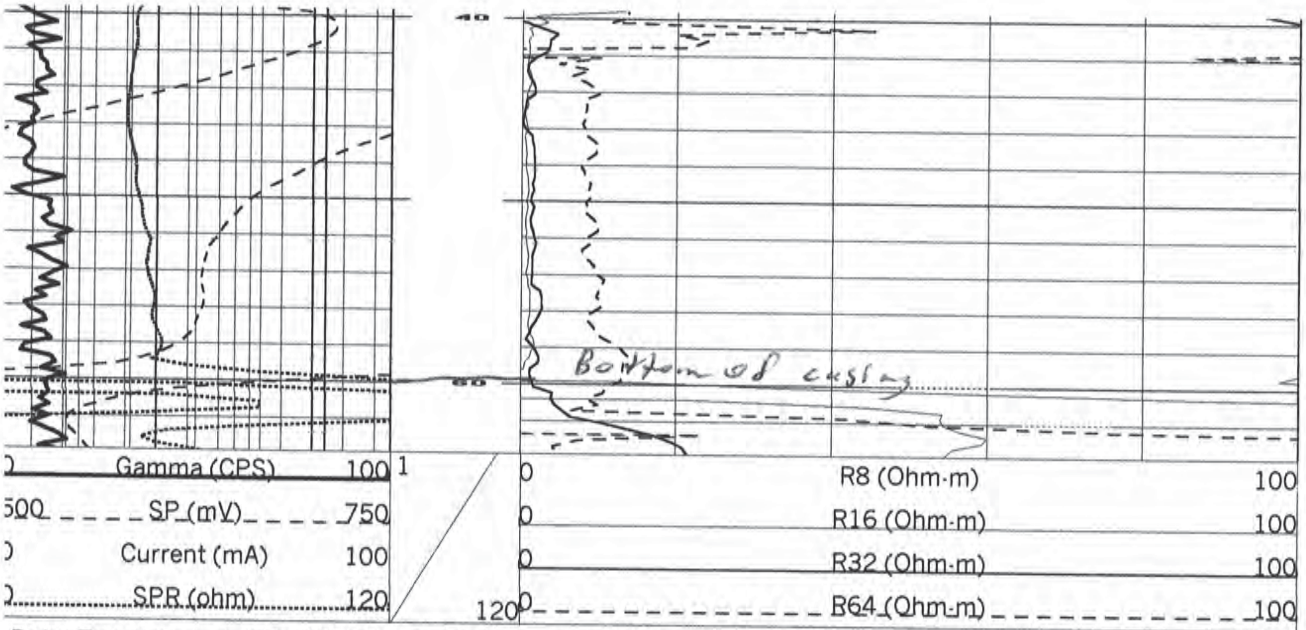
LOCATION	OTHER SERVICES
SEC TWP RGE	

PERMANENT DATUM	ELEVATION	K.B.
LOG MEAS. FROM	ABOVE PERM. DATUM	D.F.
DRILLING MEAS. FROM		G.L.

DATE		TYPE FLUID IN HOLE	
RUN No		SALINITY	
TYPE LOG		DENSITY	
DEPTH-DRILLER		LEVEL	
DEPTH-LOGGER		MAX. REC. TEMP.	
BTM LOGGED INTERVAL			
TOP LOGGED INTERVAL			
OPERATING RIG TIME			
RECORDED BY			
WITNESSED BY			

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO





Date: Tuesday, June 27, 2017 Time: 14:46 File: C:\My Documents\skipper\gma state port site 1 wilm..rd

Open hole 60-70 —

Print Form

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Richard Skipper
Well Contractor Name

2481 A
NC Well Contractor Certification Number

Skipper's Well Drilling & Pump Service
Company Name

2. Well Construction Permit #: WM0801094
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:

☐ Agricultural
☐ Geothermal (Heating/Cooling Supply)
☐ Industrial/Commercial
☐ Irrigation
☐ Municipal/Public
☐ Residential Water Supply (single)
☐ Residential Water Supply (shared)

Non-Water Supply Well:

☒ Monitoring
☐ Recovery

Injection Well:

☐ Aquifer Recharge
☐ Aquifer Storage and Recovery
☐ Aquifer Test
☐ Experimental Technology
☐ Geothermal (Closed Loop)
☐ Geothermal (Heating/Cooling Return)
☐ Groundwater Remediation
☐ Salinity Barrier
☐ Stormwater Drainage
☐ Subsidence Control
☐ Tracer
☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 6/27/2017 **Well ID#** Lower PD

5a. Well Location:

NC State Port Authority
Facility/Owner Name

Facility ID# (if applicable)

S. Front Street, Wilmington, N. C. 28401
Physical Address, City, and Zip

New Hanover
County

R05320-001-001-000
Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

34.217172° N -77.951067° W

6. Is(are) the well(s): ☒ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☒ **No**
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. **For Geoprobe/DPT or Closed-Loop Geothermal Wells** having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: Three (3)

9. Total well depth below land surface: 70 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 60 **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
60 ft.	70 ft.	Sand & Limestore
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
60 ft.	70 ft.	2 in.	10	Sch 40	PVC
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	58 ft.	Mud Grout	Pumped
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
58 ft.	71 ft.		
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	40 ft.	Overburdened Sand & Shell
40 ft.	50 ft.	Clay Sand
50 ft.	70 ft.	Sand Limestone
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Richard N Skipper 9/13/2017
Signature of Certified Well Contractor Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells: In addition to sending the form to the address in 24a above, also submit one copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

Print Form

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Richard Skipper
Well Contractor Name

2481-A
NC Well Contractor Certification Number

Skipper's Well Drilling & Pump Service, Inc.
Company Name

2. Well Construction Permit #: WM0801094
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:
- ☐ Agricultural
- ☐ Municipal/Public
- ☐ Geothermal (Heating/Cooling Supply)
- ☐ Residential Water Supply (single)
- ☐ Industrial/Commercial
- ☐ Residential Water Supply (shared)
- ☐ Irrigation

Non-Water Supply Well:
- ☒ Monitoring
- ☐ Recovery

Injection Well:
- ☐ Aquifer Recharge
- ☐ Groundwater Remediation
- ☐ Aquifer Storage and Recovery
- ☐ Salinity Barrier
- ☐ Aquifer Test
- ☐ Stormwater Drainage
- ☐ Experimental Technology
- ☐ Subsidence Control
- ☐ Geothermal (Closed Loop)
- ☐ Tracer
- ☐ Geothermal (Heating/Cooling Return)
- ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 6/28/2107 **Well ID#** Surficial Aquifer

5a. Well Location:

NC Port Authority
Facility/Owner Name

Facility ID# (if applicable)

S. Front Street, Wilmington, NC 28401
Physical Address, City, and Zip

New Hanover
County

R05320-001-001-00
Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

34.217163° N -77.951327° W

6. Is(are) the well(s): ☒ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☒ **No**
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: Three (3)

9. Total well depth below land surface: 15 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 5 **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
5 ft.	15 ft.	Sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
5 ft.	10 ft.	2 in.	10	Sch 40	PVC
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Mud Grout	Powered
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
3 ft.	11 ft.	#2 Morrie	Powered
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	16 ft.	Overburdened Sand
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Richard M. Skipper 9/13/2017
Signature of Certified Well Contractor Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells: In addition to sending the form to the address in 24a above, also submit one copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

Print Form

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Richard Skipper
Well Contractor Name

2481 A
NC Well Contractor Certification Number

Skipper's Well Drilling & Pump Service, Inc.
Company Name

2. Well Construction Permit #: WM0801094
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:

☐ Agricultural ☐ Municipal/Public
☐ Geothermal (Heating/Cooling Supply) ☐ Residential Water Supply (single)
☐ Industrial/Commercial ☐ Residential Water Supply (shared)
☐ Irrigation

Non-Water Supply Well:

☒ Monitoring ☐ Recovery

Injection Well:

☐ Aquifer Recharge ☐ Groundwater Remediation
☐ Aquifer Storage and Recovery ☐ Salinity Barrier
☐ Aquifer Test ☐ Stormwater Drainage
☐ Experimental Technology ☐ Subsidence Control
☐ Geothermal (Closed Loop) ☐ Tracer
☐ Geothermal (Heating/Cooling Return) ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 6/28/2017 **Well ID#** Upper PD

5a. Well Location:

NC State Port Authority
Facility/Owner Name
Facility ID# (if applicable)

S Front St. Wilmington, NC 28401
Physical Address, City, and Zip

New Hanover
County

R05320-001-001-000
Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

34.217181° N -77.951191° W

6. Is(are) the well(s): ☒ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☒ **No**
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: Three (3

9. Total well depth below land surface: 35 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 25 **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
25 ft.	35 ft.	Sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
25 ft.	35 ft.	2 in.	10	Sch 40	PVC
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	23 ft.	Mud Grout	Pumped
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
23 ft.	36 ft.	#2 gravel	pumped
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	20 ft.	Overburdened Sand
20 ft.	37 ft.	Sand & Shell
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Richard M. Skipper
Signature of Certified Well Contractor

9-13-17
Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

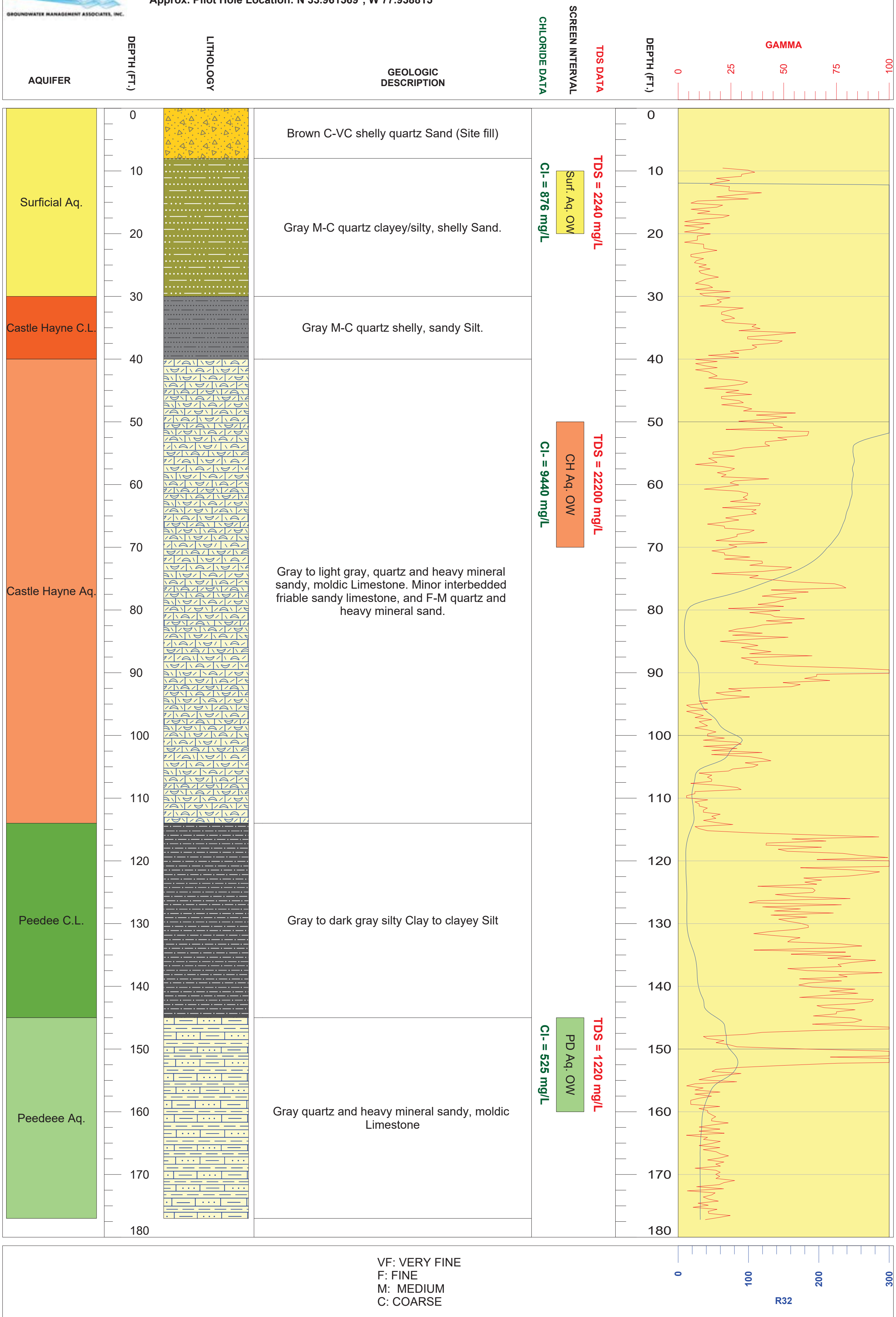
24b. For Injection Wells: In addition to sending the form to the address in 24a above, also submit one copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

SITE #2-FT. FISHER OW'S

GMA Project #: 160001
FT. FISHER FERRY, NEW HANOVER COUNTY, NORTH CAROLINA
Approx. Pilot Hole Location: N 33.961569°, W 77.938815°



VF: VERY FINE
F: FINE
M: MEDIUM
C: COARSE

Fort Fisher Mon

CO **New Hanover**
WELL
FLD
CTY **Kure Beach**
STE
FILING No

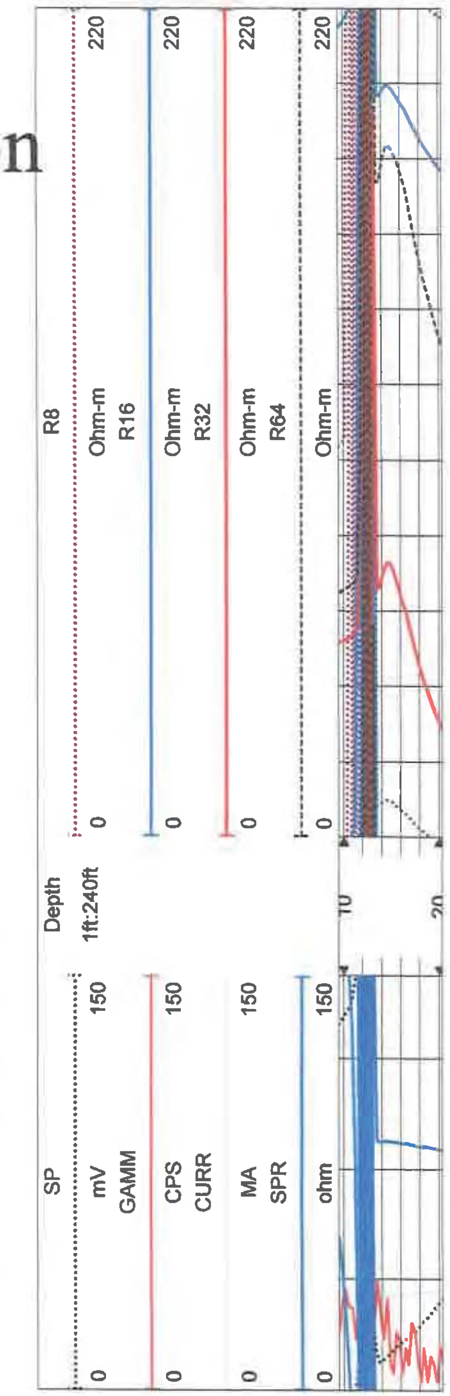
COMPANY	Magette Well & Pump Co		
WELL ID	Fort Fisher Monitoring Well		
FIELD			
COUNTRY		STATE	NC

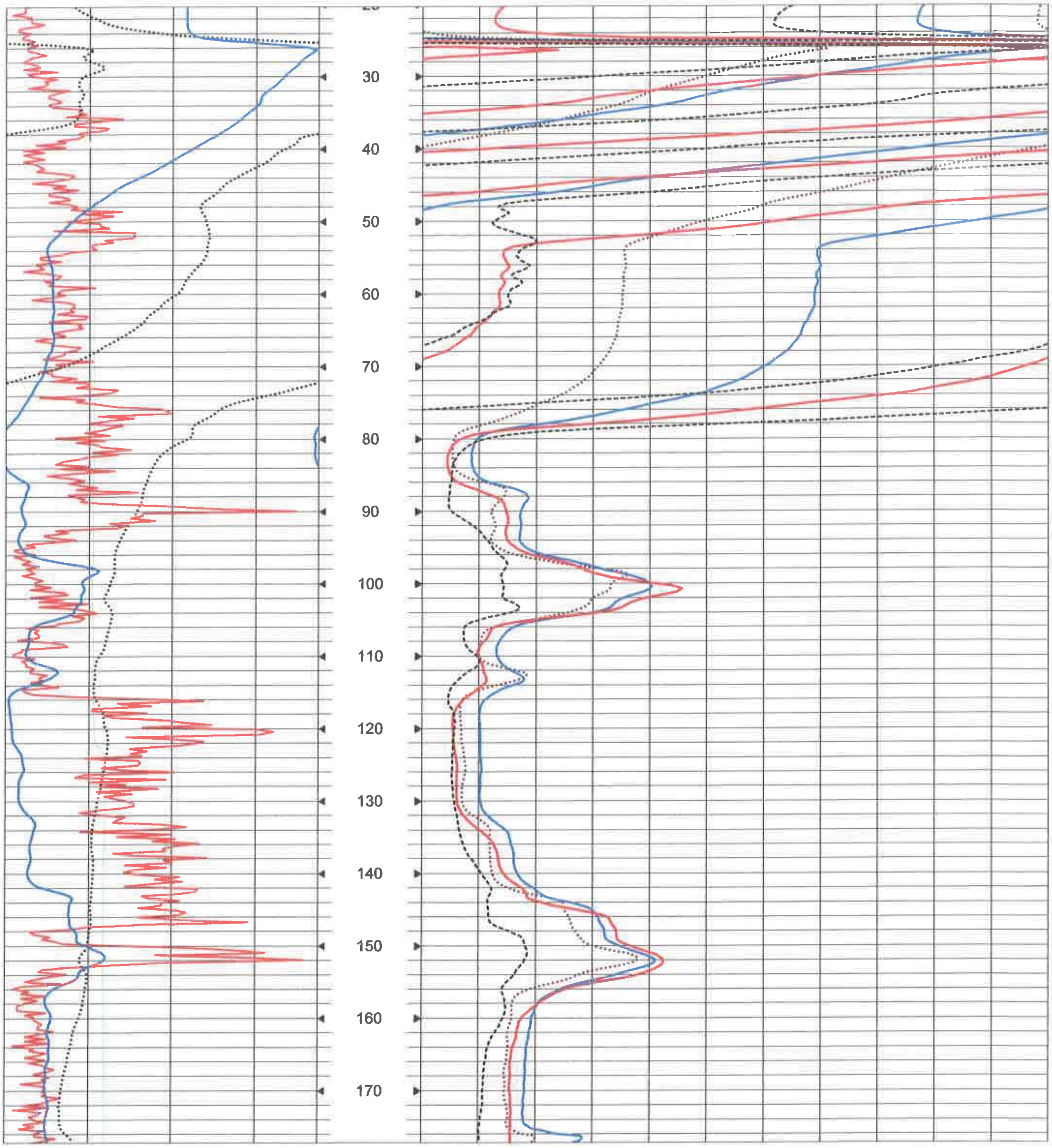
LOCATION 33.961587 -77.938812 SEC TWP RGE	OTHER SERVICES

PERMANENT DATUM	ELEVATION	K.B.
LOG MEAS. FROM	ABOVE PERM. DATUM	D.F.
DRILLING MEAS. FROM		G.L.

DATE	8/16/2017	TYPE FLUID IN HOLE	
RUN No		SALINITY	
TYPE LOG		DENSITY	
DEPTH-DRILLER	178'	LEVEL	
DEPTH-LOGGER	175'	MAX. REC. TEMP.	
BTM LOGGED INTERVAL			
TOP LOGGED INTERVAL			
OPERATING RIG TIME			
RECORDED BY	Jimmy Morris		
WITNESSED BY			

RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO
	11.75"	0-50'		8" PVC		0-50'	
	5.75	50-178'					




30
40
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70
80
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110
120
130
140
150
160
170

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

For Internal Use ONLY:

1. Well Contractor Information:

Jimmy Morris

Well Contractor Name

4193-A

NC Well Contractor Certification Number

MAGETTE WELL & PUMP COMPANY

Company Name

2. Well Construction Permit #: ______

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 8/24/17 **Well ID#** Fort Fisher

5a. Well Location:

NC State Port Authority — Facility/Owner Name

PD — Facility ID# (if applicable)

2202 Burnett Blvd, Wilmington NC 28401

Physical Address, City, and Zip

New Hanover — County

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

33.961586 N -77.938811 W

6. Is (are) the well(s): ☑**Permanent** or ☐**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 160 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 12.42 **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6 **(in.)**

12. Well construction method: ROTARY

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

14. WATER ZONES

FROM	TO	DESCRIPTION
145 ft.	160 ft.	Sand stone and course sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	48 ft.	8 in.	SDR17	PVC

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+2.5 ft.	145 ft.	3 in.	SCH 40	PVC
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
145 ft.	160 ft.	2 in.	.020	SCH 40	PVC
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	125 ft.	Portland	Pumped
125 ft.	130 ft.	Bentonite	Pumped
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
130 ft.	170 ft.	SP NO. 2	Tremie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	6 ft.	Dredgrad sand
6 ft.	44 ft.	Fine to medium sand
44 ft.	48 ft.	Dense black clay
48 ft.	74 ft.	Sand and Limestone
74 ft.	78 ft.	Clay
78 ft.	81 ft.	Blue gray very hard stone
81 ft.	94 ft.	Very hard white sand stone

21. REMARKS

94' to 110' Hard white sand stone, 110' to 135' Sand stone with white soft clay, 135' to 170' softer white sand stone with cours

22. Certification:

Signature of Certified Well Contractor — Date: 9.6.17

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. **For All Wells:** Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. **For Injection Wells ONLY:** In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. **For Water Supply & Injection Wells:**
Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

Jimmy Morris

Well Contractor Name

4193-A

NC Well Contractor Certification Number

MAGETTE WELL & PUMP COMPANY

Company Name

2. Well Construction Permit #: ______

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 8/24/17 **Well ID#** Fort Fisher

5a. Well Location:

NC State Port Authority

Facility/Owner Name

(Surficial)

Facility ID# (if applicable)

2202 Burnett Blvd, Wilmington NC 28401

Physical Address, City, and Zip

New Hanover

County

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

33.961499 N -77.938725 W

6. Is (are) the well(s): ☑**Permanent** or ☐**Temporary**

7. Is this a repair to an existing well: ☐Yes or ☑No

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 20 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 11.04 **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 5.5 **(in.)**

12. Well construction method: ROTARY

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
10 ft.	20 ft.	Fine sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+2.5 ft.	10 ft.	2 in.	SCH 40	PVC
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
10 ft.	20 ft.	2 in.	.020	SCH 40	PVC
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	2 ft.	Cement	poured
2 ft.	8 ft.	hole plug	poured
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
8 ft.	23 ft.	SP NO. 2	poured
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	6 ft.	Dredgrad sand
6 ft.	23 ft.	fine sand
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Signature of Certified Well Contractor

9.6.17

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:
Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

Jimmy Morris
Well Contractor Name

4193-A
NC Well Contractor Certification Number

MAGETTE WELL & PUMP COMPANY
Company Name

2. Well Construction Permit #: ______
List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

- ☐Agricultural
- ☐Geothermal (Heating/Cooling Supply)
- ☐Industrial/Commercial
- ☐Irrigation
- ☐Municipal/Public
- ☐Residential Water Supply (single)
- ☐Residential Water Supply (shared)

Non-Water Supply Well:

- ☑Monitoring
- ☐Recovery

Injection Well:

- ☐Aquifer Recharge
- ☐Aquifer Storage and Recovery
- ☐Aquifer Test
- ☐Experimental Technology
- ☐Geothermal (Closed Loop)
- ☐Geothermal (Heating/Cooling Return)
- ☐Groundwater Remediation
- ☐Salinity Barrier
- ☐Stormwater Drainage
- ☐Subsidence Control
- ☐Tracer
- ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 8/24/17 **Well ID#** Fort Fisher

5a. Well Location:

NC State Port Authority
Facility/Owner Name

Castle Hayne
Facility ID# (if applicable)

2202 Burnett Blvd, Wilmington NC 28401
Physical Address, City, and Zip

New Hanover
County

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

33.961496 N -77.938716 W

6. Is (are) the well(s): ☑**Permanent** or ☐**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1
For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 70 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 11.10 **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: 7.875 **(in.)**

12. Well construction method: ROTARY
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
50 ft.	70 ft.	Sand and Limestone
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	46 ft.	8 in.	SCH 40	PVC

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+2.5 ft.	50 ft.	4 in.	SCH 40	PVC
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
50 ft.	70 ft.	4 in.	.030	SCH 40	PVC
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	40 ft.	Portland	Pumped
40 ft.	42 ft.	Bentonite	poured
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
42 ft.	74 ft.	SP NO. 2	Tremie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	6 ft.	Dredgrad sand
6 ft.	44 ft.	Fine to medium sand
44 ft.	48 ft.	Dense black clay
48 ft.	74 ft.	Sand and Limestone
74 ft.	78 ft.	Clay
78 ft.	81 ft.	Blue gray very hard stone
81 ft.	94 ft.	Very hard white sand stone

21. REMARKS

94' to 110' Hard white sand stone, 110' to 135' Sand stone
with white soft clay, 135' to 170' softer white sand stone with cours

22. Certification:

Signature of Certified Well Contractor

9.6.17
Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

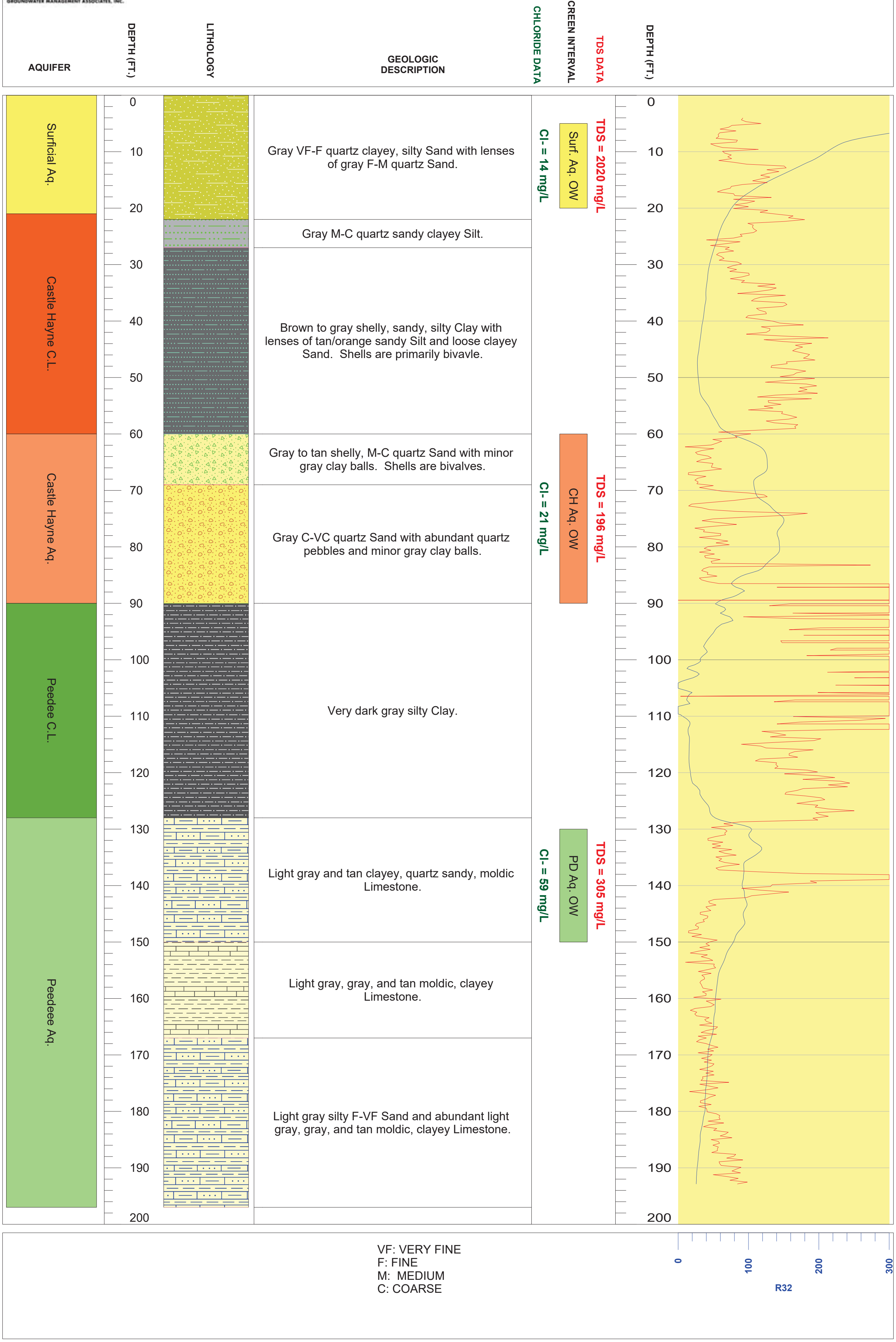
24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:
Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

SITE #3-SOUTHPORT OW'S

GMA Project #: 160001
SOUTHPORT, BURNSWICK COUNTY, NORTH CAROLINA
Approx. Pilot Hole Location: N 33.947567°, W 77.985486°



Gray VF-F quartz clayey, silty Sand with lenses of gray F-M quartz Sand.

Gray M-C quartz sandy clayey Silt.

Brown to gray shelly, sandy, silty Clay with lenses of tan/orange sandy Silt and loose clayey Sand. Shells are primarily bivavle.

Gray to tan shelly, M-C quartz Sand with minor gray clay balls. Shells are bivalves.

Gray C-VC quartz Sand with abundant quartz pebbles and minor gray clay balls.

Very dark gray silty Clay.

Light gray and tan clayey, quartz sandy, moldic Limestone.

Light gray, gray, and tan moldic, clayey Limestone.

Light gray silty F-VF Sand and abundant light gray, gray, and tan moldic, clayey Limestone.

VF: VERY FINE
F: FINE
M: MEDIUM
C: COARSE

Date: Tuesday, April 04, 2017 Time: 14:41 File: C:\My Documents\skipper\PD MW SITE 3.rd

CO
WELL
FLD
CTY
STE
FILING No

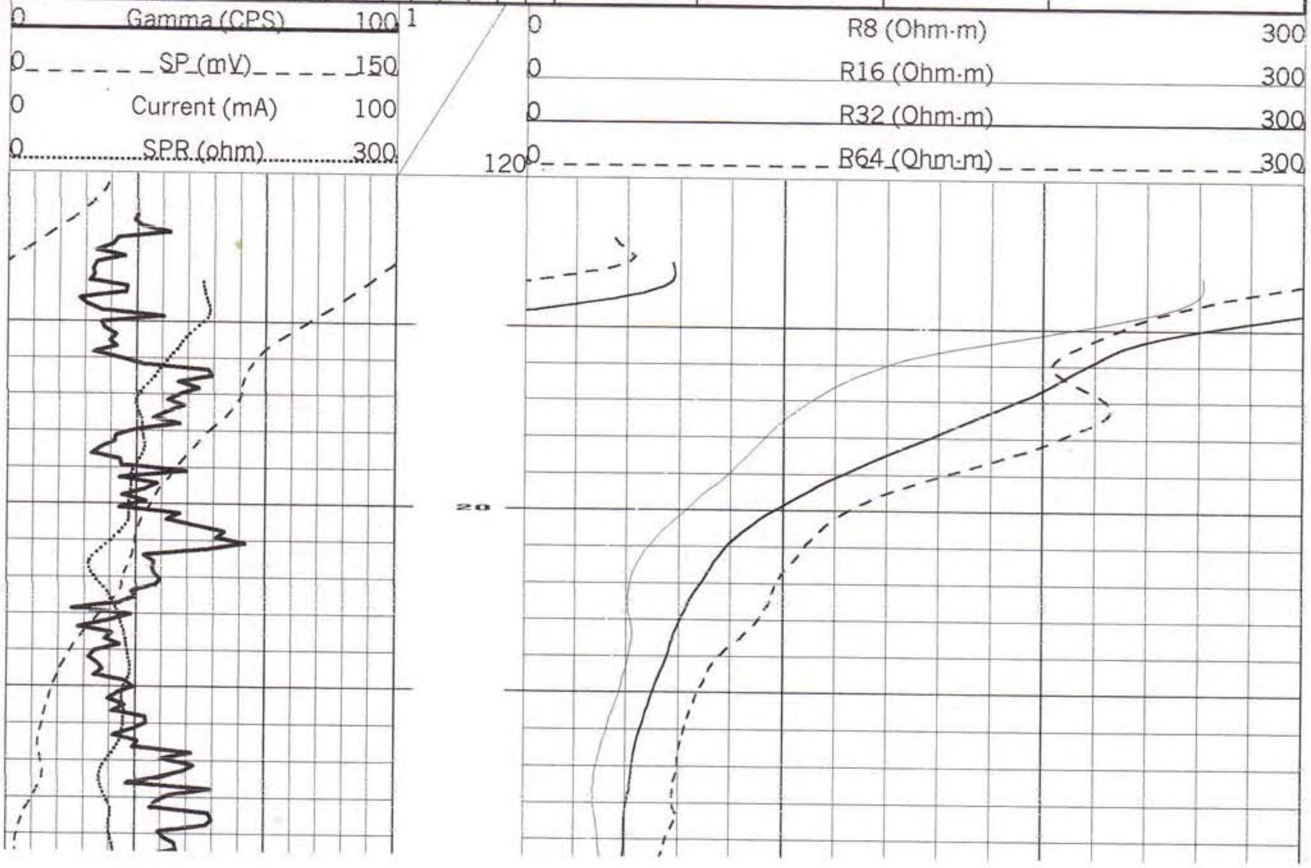
COMPANY
WELL ID
FIELD
COUNTRY
STATE
LOCATION
OTHER SERVICES
SEC TWP RGE

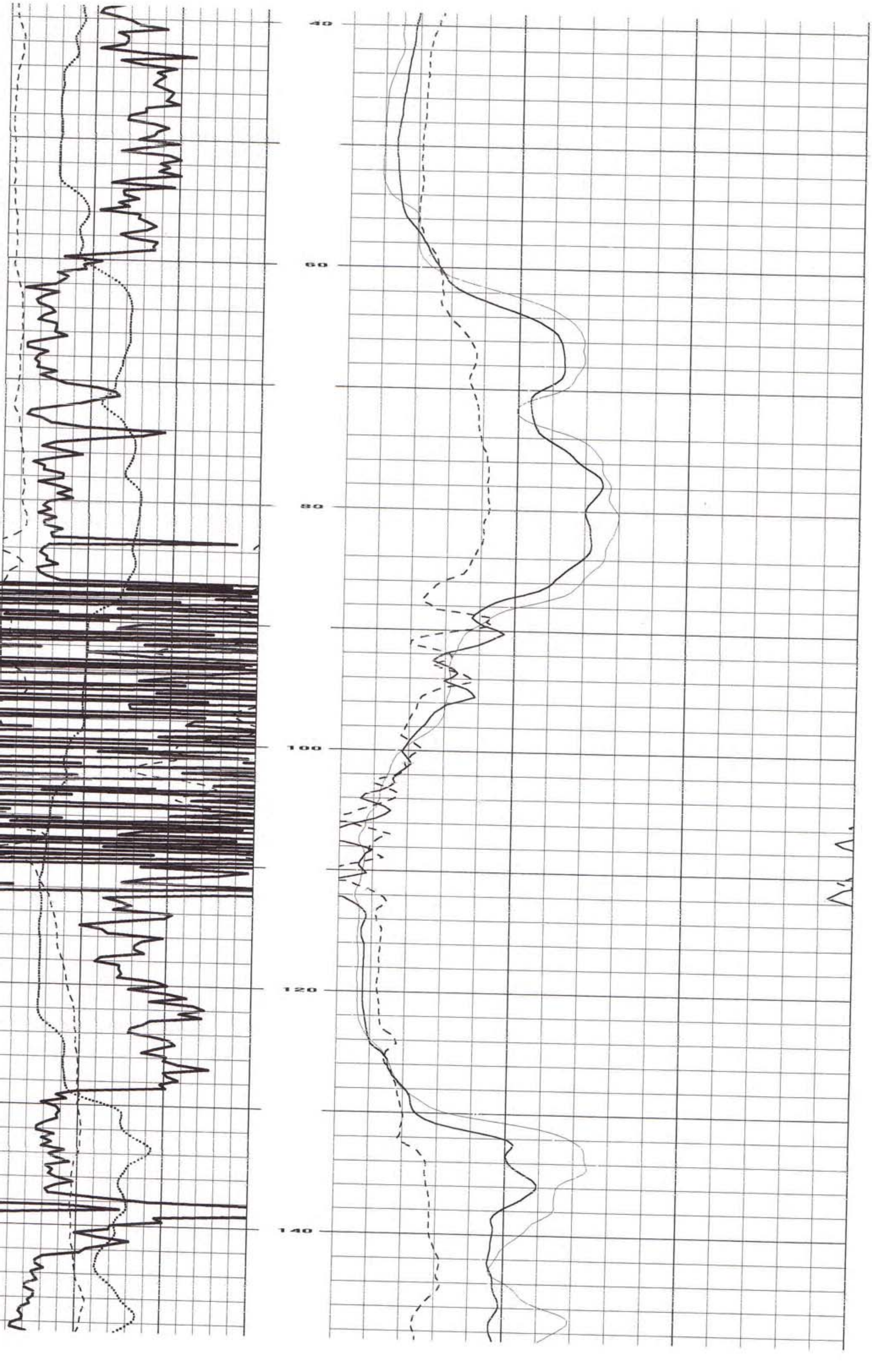
PERMANENT DATUM ELEVATION K.B.
LOG MEAS. FROM ABOVE PERM. DATUM D.F.
DRILLING MEAS. FROM G.L.

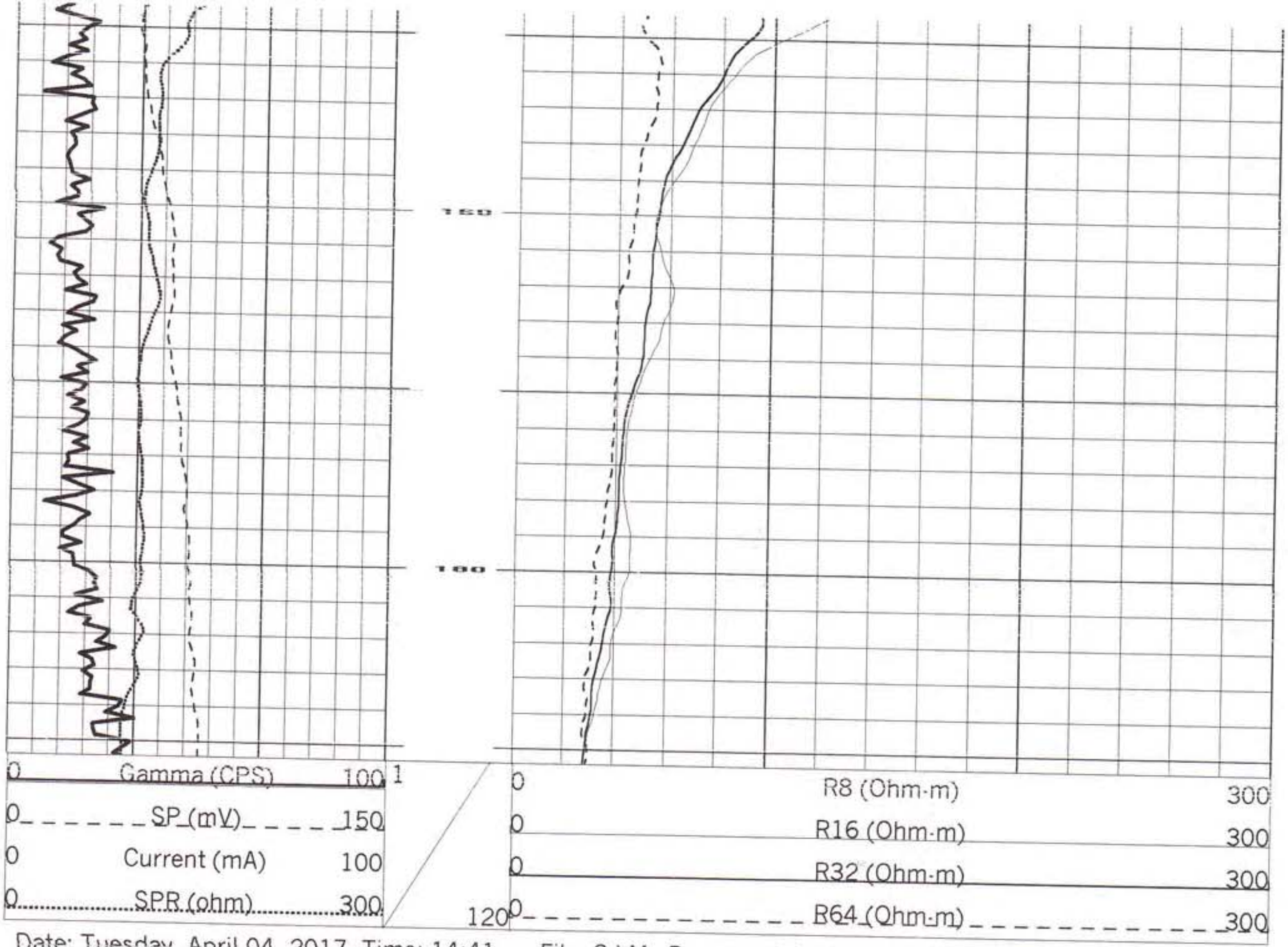
DATE
RUN No
TYPE LOG
DEPTH-DRILLER
DEPTH-LOGGER
BTM LOGGED INTERVAL
TOP LOGGED INTERVAL
OPERATING RIG TIME
RECORDED BY
WITNESSED BY

TYPE FLUID IN HOLE
SALINITY
DENSITY
LEVEL
MAX. REC. TEMP.

BOREHOLE RECORD				CASING RECORD			
RUN NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO




40
60
80
100
120
140



0 Gamma (CPS) 100 1
0 SP (mV) 150
0 Current (mA) 100
0 SPR (ohm) 300 120
0 R8 (Ohm-m) 300
0 R16 (Ohm-m) 300
0 R32 (Ohm-m) 300
0 R64 (Ohm-m) 300

Date: Tuesday, April 04, 2017 Time: 14:41 File: C:\My Documents\skipper\PD MW SITE 3.rd

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Larry Skipper

Well Contractor Name

2483-A

NC Well Contractor Certification Number

Skipper's Well Drilling & Pump Service Inc

Company Name

2. Well Construction Permit #: ______

List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:

☐ Agricultural
☐ Geothermal (Heating/Cooling Supply)
☐ Industrial/Commercial
☐ Irrigation
☐ Municipal/Public
☐ Residential Water Supply (single)
☐ Residential Water Supply (shared)

Non-Water Supply Well:

☒ Monitoring
☐ Recovery

Injection Well:

☐ Aquifer Recharge
☐ Aquifer Storage and Recovery
☐ Aquifer Test
☐ Experimental Technology
☐ Geothermal (Closed Loop)
☐ Geothermal (Heating/Cooling Return)
☐ Groundwater Remediation
☐ Salinity Barrier
☐ Stormwater Drainage
☐ Subsidence Control
☐ Tracer
☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: May 1, 2017 **Well ID#** ______

5a. Well Location:

NC State Ports Authority

Facility/Owner Name

Facility ID# (if applicable)

Shephard Rd. SE, Southport NC

Physical Address, City, and Zip

Brunswick

County

300700645484

Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

33.947537* N 77.985505* W

6. Is(are) the well(s): ☒ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☒ **No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: three

9. Total well depth below land surface: 90 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 26 **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8 1/2 **(in.)**

12. Well construction method: Rotary

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ______ **Method of test:** ______

13b. Disinfection type: ______ **Amount:** ______

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
60 ft.	90 ft.	
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
none ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	60 ft.	4 in.	sch40	pvc
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
60 ft.	90 ft.	4 in.	30	sch40	pvc
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	40 ft.	cement	tremie
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
50 ft.	90 ft.	#2	treme
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

40 to 50 ben. seal

22. Certification:

Larry Skipper May 3,2017

Signature of Certified Well Contractor Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells: In addition to sending the form to the address in 24a above, also submit one copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Larry Skipper

Well Contractor Name

2483-A

NC Well Contractor Certification Number

Skipper's Well Drilling & Pump Service Inc

Company Name

2. Well Construction Permit #: ____________________

List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:

- ☐ Agricultural
- ☐ Geothermal (Heating/Cooling Supply)
- ☐ Industrial/Commercial
- ☐ Irrigation
- ☐ Municipal/Public
- ☐ Residential Water Supply (single)
- ☐ Residential Water Supply (shared)

Non-Water Supply Well:

- ☒ Monitoring
- ☐ Recovery

Injection Well:

- ☐ Aquifer Recharge
- ☐ Aquifer Storage and Recovery
- ☐ Aquifer Test
- ☐ Experimental Technology
- ☐ Geothermal (Closed Loop)
- ☐ Geothermal (Heating/Cooling Return)
- ☐ Groundwater Remediation
- ☐ Salinity Barrier
- ☐ Stormwater Drainage
- ☐ Subsidence Control
- ☐ Tracer
- ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: May 1, 2017 **Well ID#** ____________

5a. Well Location:

NC State Ports Authority

Facility/Owner Name

Facility ID# (if applicable)

Shephard Rd. SE, Southport

Physical Address, City, and Zip

Brunswick

County

300700645484

Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

33.947602* N 77.985400* W

6. Is(are) the well(s): ☒ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☒ **No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: three

9. Total well depth below land surface: 0 to 150 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 32' **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8 1/2 **(in.)**

12. Well construction method: Rotary

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) __________ **Method of test:** __________

13b. Disinfection type: __________ **Amount:** __________

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
130 ft.	150 ft.	
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
none ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	130 ft.	4 in.	sch 40	pvc
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
130 ft.	150 ft.	4 in.	30	sch 40	pvc
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	110 ft.	cement	tremie
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
120 ft.	150 ft.	#2 S. P.	tremie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

Ben Seal 110 to 120

22. Certification:

Larry Skipper May 3, 2017

Signature of Certified Well Contractor Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells: In addition to sending the form to the address in 24a above, also submit one copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Larry Skipper

Well Contractor Name

2483-A

NC Well Contractor Certification Number

Skipper's Well Drilling & Pump Service Inc

Company Name

2. Well Construction Permit #: ____________

List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:

- ☐ Agricultural
- ☐ Geothermal (Heating/Cooling Supply)
- ☐ Industrial/Commercial
- ☐ Irrigation
- ☐ Municipal/Public
- ☐ Residential Water Supply (single)
- ☐ Residential Water Supply (shared)

Non-Water Supply Well:

- ☒ Monitoring
- ☐ Recovery

Injection Well:

- ☐ Aquifer Recharge
- ☐ Aquifer Storage and Recovery
- ☐ Aquifer Test
- ☐ Experimental Technology
- ☐ Geothermal (Closed Loop)
- ☐ Geothermal (Heating/Cooling Return)
- ☐ Groundwater Remediation
- ☐ Salinity Barrier
- ☐ Stormwater Drainage
- ☐ Subsidence Control
- ☐ Tracer
- ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: May 1, 2017 **Well ID#** ____________

5a. Well Location:

NC State Ports Authority

Facility/Owner Name

Facility ID# (if applicable)

Shephard Rd. SE Southport NC

Physical Address, City, and Zip

Brunswick

County

300700645484

Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

33.94779* N 77.985618* W

6. Is(are) the well(s): ☒ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☒ **No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: three

9. Total well depth below land surface: 20 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 13 **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6 **(in.)**

12. Well construction method: Rotary

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) ____________ **Method of test:** ____________

13b. Disinfection type: ____________ **Amount:** ____________

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
13 ft.	20 ft.	sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	20 ft.	2 in.	sch40	pvc
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
5 ft.	20 ft.	2 in.	10	sch40	pvc
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	cement	tremie
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
3 ft.	20 ft.	#2	tremie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	5 ft.	clay
5 ft.	20 ft.	fine sand
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Larry Skipper

Signature of Certified Well Contractor

May 3, 2017

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

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1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells: In addition to sending the form to the address in 24a above, also submit one copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells: In addition to sending the form to the address(es) above, also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

Site Photographs from Drilling and Sampling at Monitoring Well Stations

Site #1 – Front Street, Wilmington

Site #1 – Front Street looking north toward the Buckeye Terminal bulk fuel storage facility.

Monitoring well drilling at Site #1 – Front Street

Air-rotary drilling of the Peedee Aquifer monitoring well, Site #1 – Front Street

Site #1 - Front Street looking northwest toward the Cape Fear River and the adjacent marsh.

Groundwater sampling at Site #1 – Front Street

Site #2 – Fort Fisher Ferry Landing


Aug 14, 2017

Drilling at Site #2 – Fort Fisher Ferry


Aug 31, 2017

Aquifer testing at Site #2 – Fort Fisher Ferry

Aquifer testing at Site #2 – Fort Fisher Ferry

Site #3 – Southport


Monitoring well drilling at Site #3 – Southport

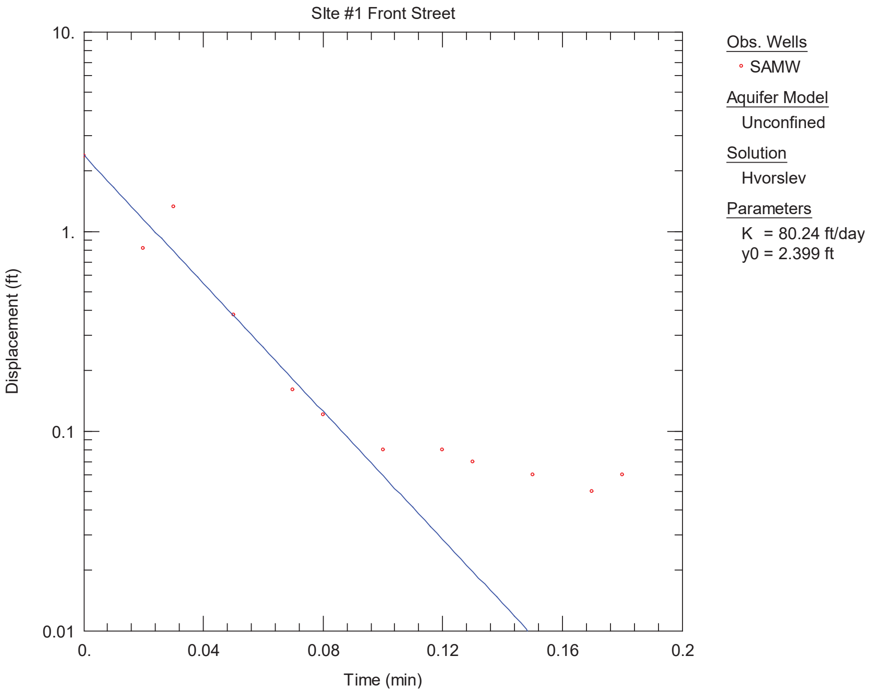

Aquifer testing at Site #3 - Southport

Wellhead Completion at Site #3 - Southport

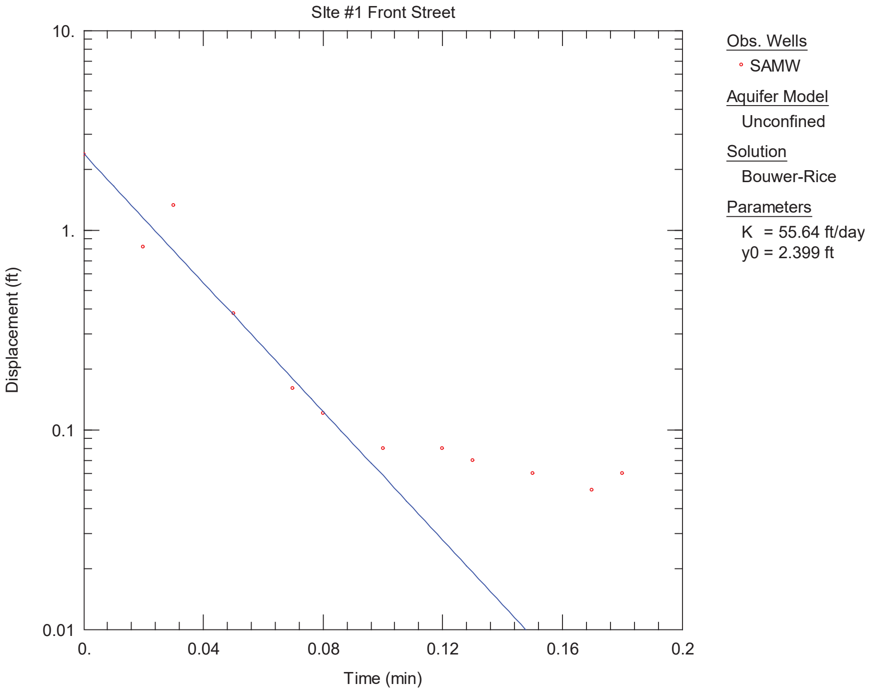
Groundwater sampling at Site #3 - Southport

Appendix III.

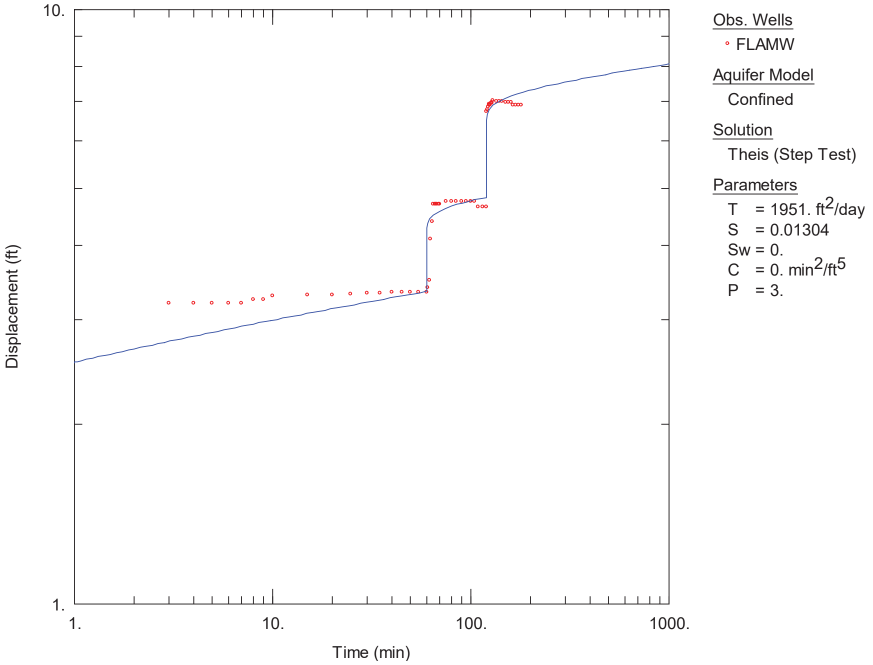
Aquifer Test Data and Analyses



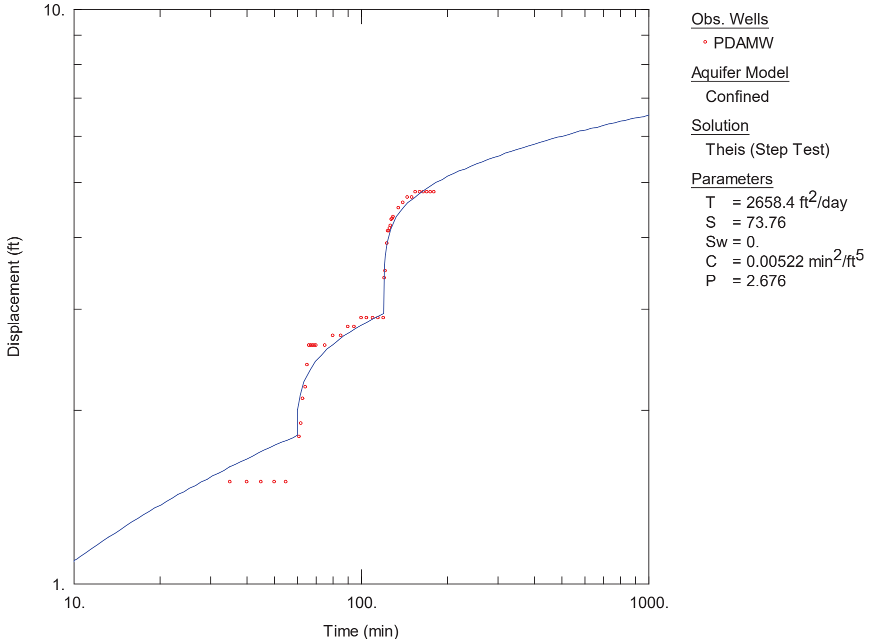
Site #1 Front Street Surficial Aquifer Slug Test Analysis by the Hvorslev Method



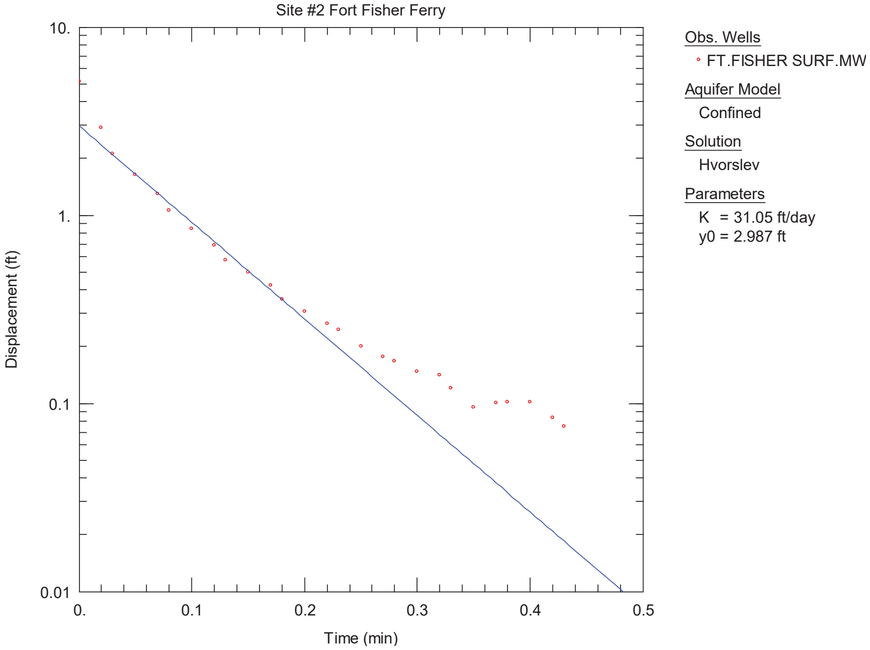
Site #1 Front Street Surficial Aquifer Slug Test Analysis by the Bouwer-Rice Method



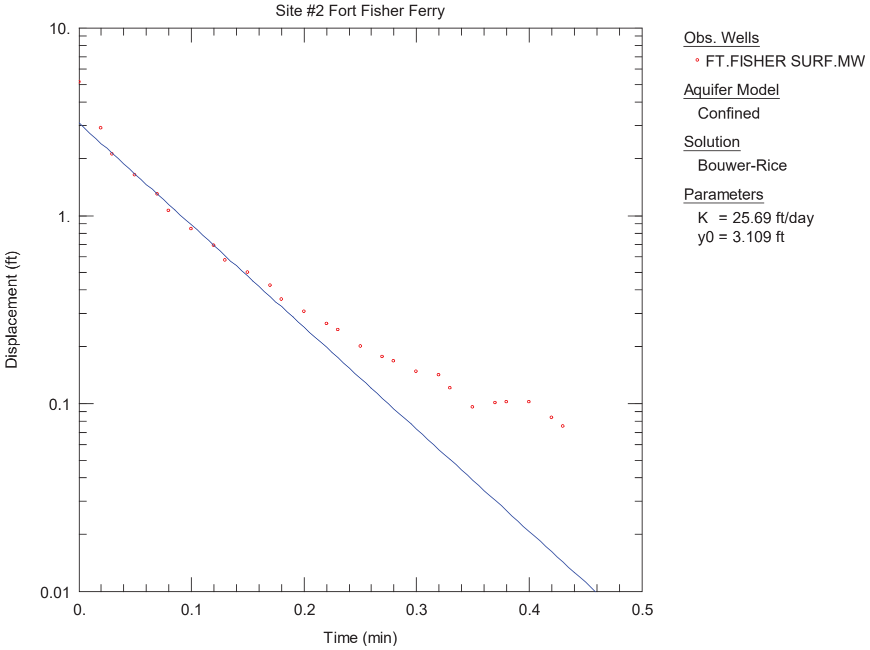
Site #1 Front Street Fluvial Aquifer Step-Drawdown Test Analysis



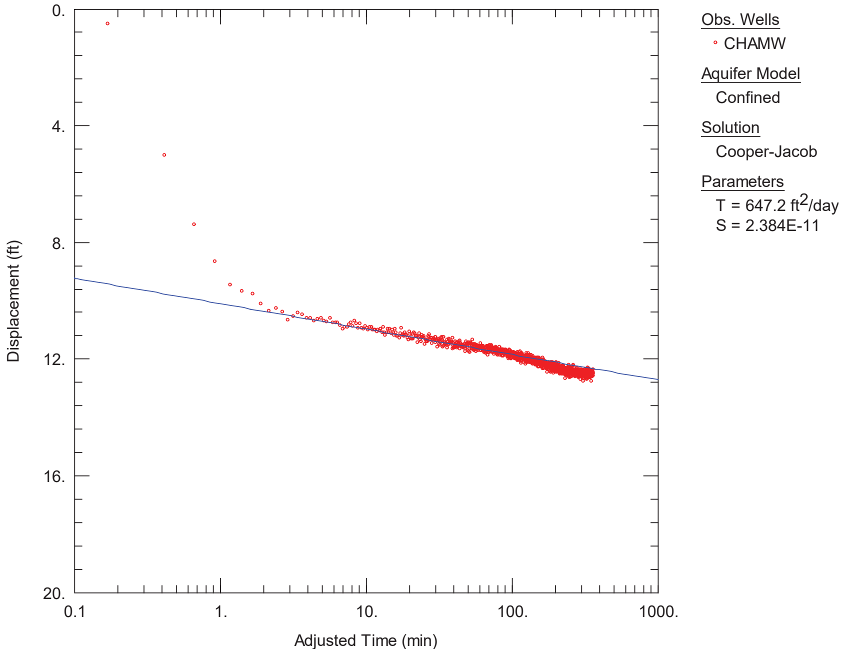
Site #1 Front Street Peedee Aquifer Step-Drawdown Test Analysis



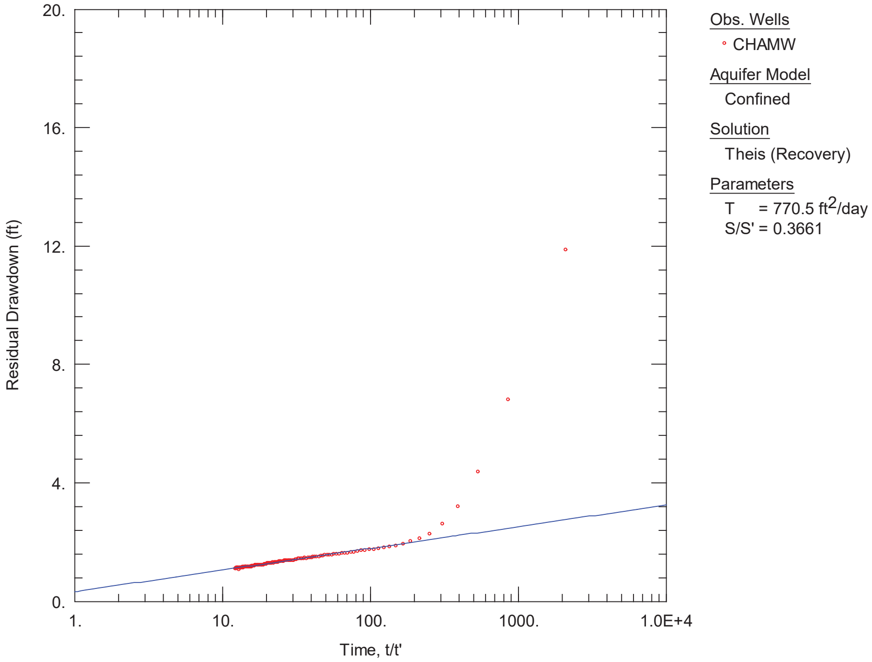
Site #2 Fort Fisher Ferry Surficial Aquifer Slug Test Analysis by the Hvorslev Method



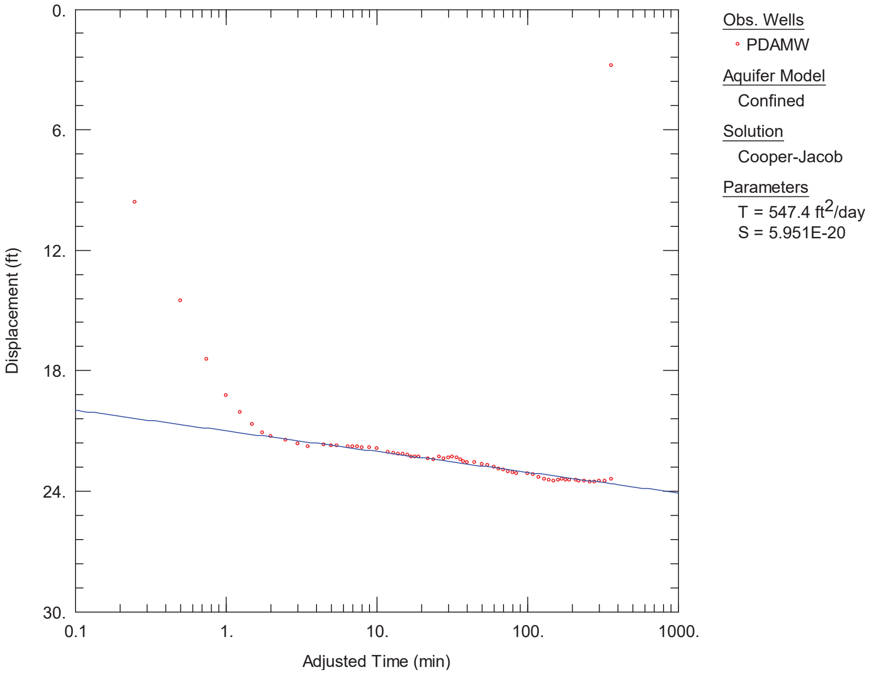
Site #2 Fort Fisher Ferry Surficial Aquifer Slug Test by the Bouwer-Rice Method



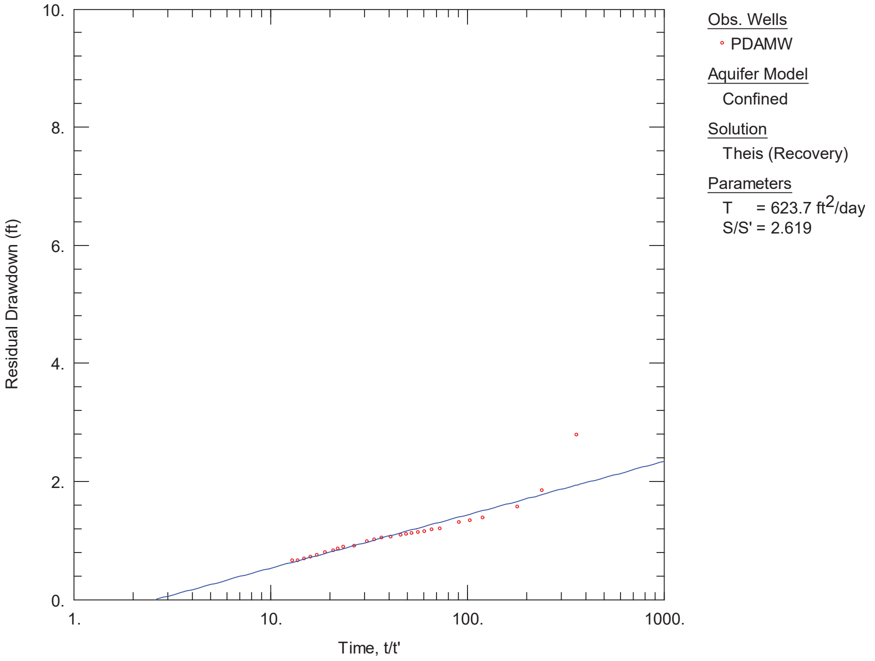
Site #2 Fort Fisher Ferry Castle Hayne Aquifer Pumping Test Analysis by the Cooper-Jacob Analysis



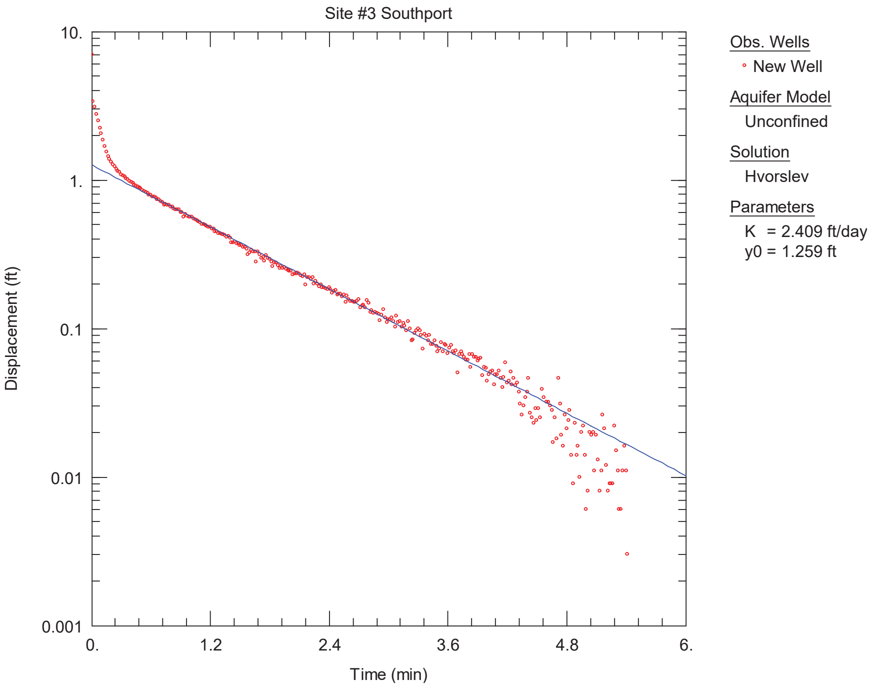
Site #2 Fort Fisher Ferry Castle Hayne Aquifer Pumping Test Analysis by the Theis Recovery Method



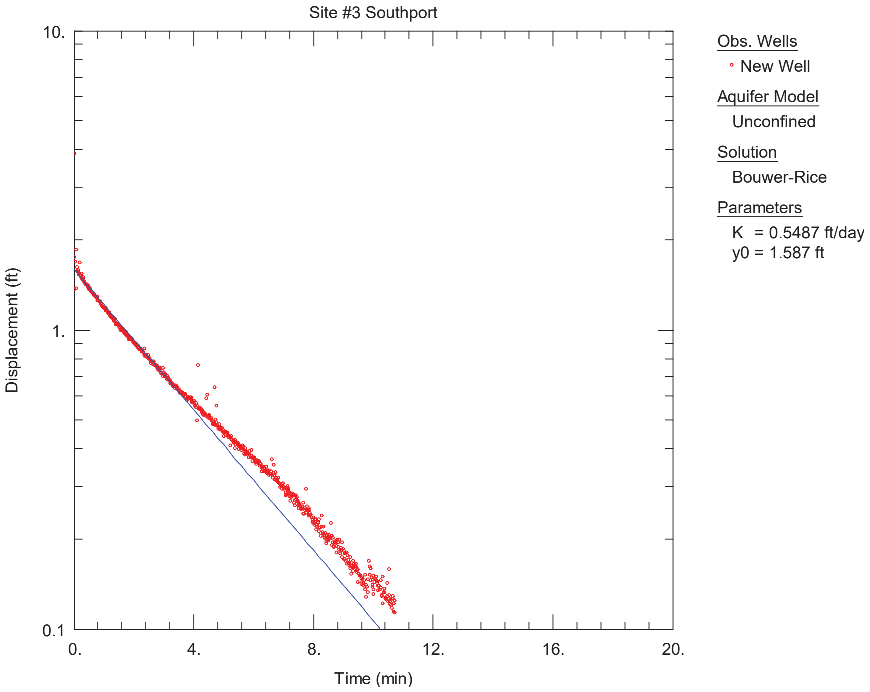
Site #2 Fort Fisher Ferry Peedee Aquifer Pumping Test Analysis by the Cooper-Jacob Analysis



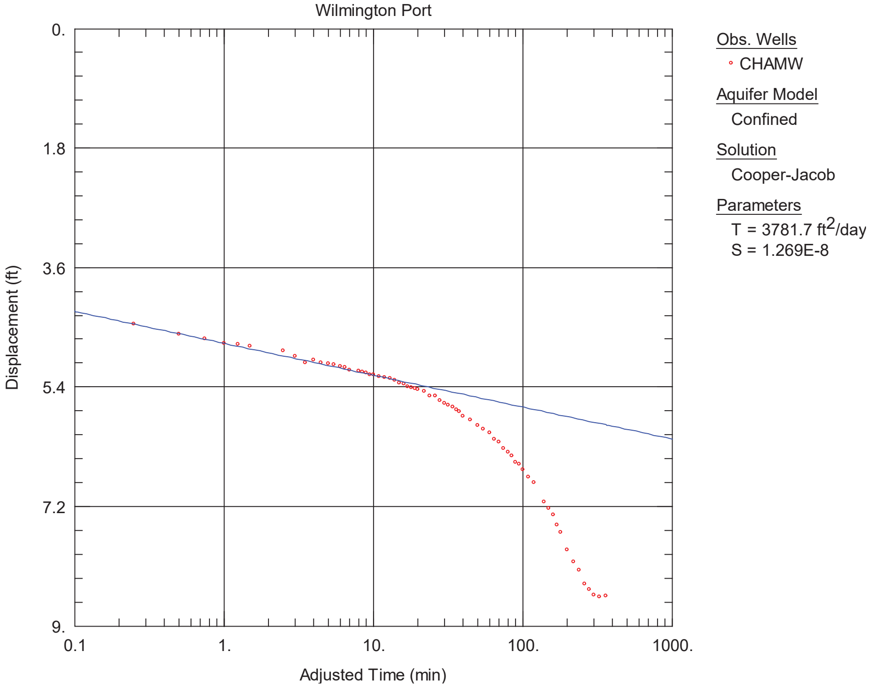
Site #2 Fort Fisher Ferry Peedee Aquifer Pumping Test Analysis by the Theis Recovery Method



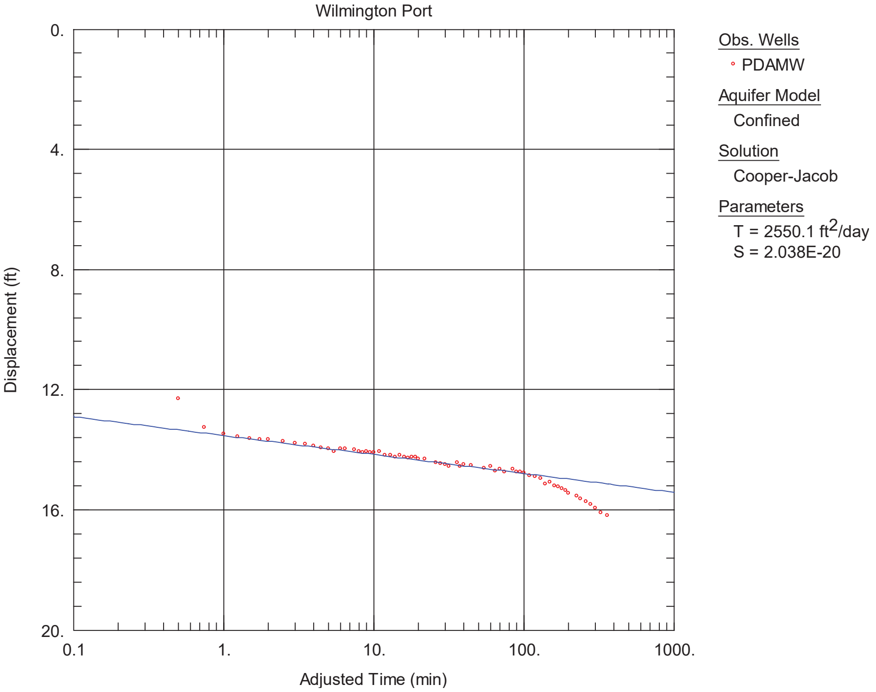
Site #3 Southport Surficial Aquifer Slug Test Analysis by the Hvorslev Method



Site #3 Southport Surficial Aquifer Slug Test Analysis by the Bouwer-Rice Method



Site #3 Southport Castle Hayne Aquifer Pumping Test Analysis by the Cooper-Jacob Analysis



Site #3 Southport Peedee Aquifer Pumping Test Analysis by the Cooper-Jacob Analysis

Appendix IV

Water-Quality Laboratory Analyses

envirochem SM

ANALYTICAL & CONSULTING CHEMISTS

Environmental Chemists, Inc.

6602 Windmill Way, Wilmington, NC 28405 • 910.392.0223 Lab • 910.392.4424 Fax
710 Bowsertown Road, Manteo, NC 27954 • 252.473.5702 Lab/Fax
255-A Wilmington Highway, Jacksonville, NC 28540 • 910.347.5843 Lab/Fax

info@environmentalchemists.com

Groundwater Management Associates
4300 Sapphire Ct, Suite 100
Greenville NC 27834
Attention: Jay Holley

Date of Report: Nov 22, 2017
Customer PO #:
Report #: 2017-17622
Customer ID: 09030031
Project ID: 160001

Lab ID	**Sample ID:**	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42689	**Site:** southport surficial	11/14/2017 10:02 AM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	2020 mg/L	11/17/2017
Chloride	SM 4500 Cl E	14 mg/L	11/16/2017

Lab ID	**Sample ID:** Duplicate	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42689A	**Site:** southport surficial	11/14/2017 10:02 AM	DW	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	2150 mg/L	11/17/2017
Chloride	SM 4500 Cl B	18 mg/L	11/15/2017

Lab ID	**Sample ID:**	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42690	**Site:** Ft. Fisher Surficial	11/14/2017 11:02 AM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	2240 mg/L	11/15/2017
Chloride	SM 4500 Cl E	876 mg/L	11/16/2017

Lab ID	**Sample ID:** Duplicate	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42690A	**Site:** Ft. Fisher Surficial	11/14/2017 11:02 AM	DW	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	2210 mg/L	11/15/2017
Chloride	SM 4500 Cl B	721 mg/L	11/15/2017

Lab ID	**Sample ID:**	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42691	**Site:** Front St. PeeDee	11/14/2017 1:05 PM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	239 mg/L	11/15/2017
Chloride	SM 4500 Cl E	17 mg/L	11/16/2017

Groundwater Management Associates
4300 Sapphire Ct, Suite 100
Greenville NC 27834
Attention: Jay Holley

Date of Report: Nov 22, 2017
Customer PO #:
Report #: 2017-17622
Customer ID: 09030031
Project ID: 160001

Lab ID	**Sample ID:** Duplicate	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42691A	**Site:** Front St. PeeDee	11/14/2017 1:05 PM	DW	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	239 mg/L	11/15/2017
Chloride	SM 4500 Cl B	19 mg/L	11/15/2017

Lab ID	**Sample ID:**	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42692	**Site:** Front St. Fluvial	11/14/2017 1:26 PM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	165 mg/L	11/15/2017
Chloride	SM 4500 Cl E	6 mg/L	11/16/2017

Lab ID	**Sample ID:** Duplicate	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42692A	**Site:** Front St. Fluvial	11/14/2017 1:26 PM	DW	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	172 mg/L	11/15/2017
Chloride	SM 4500 Cl B	8 mg/L	11/15/2017

Lab ID	**Sample ID:**	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42693	**Site:** Front St. Surficial	11/14/2017 1:34 PM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	3660 mg/L	11/15/2017
Chloride	SM 4500 Cl E	2350 mg/L	11/16/2017

Lab ID	**Sample ID:** Duplicate	**Collect Date/Time**	**Matrix**	**Sampled by**
17-42693A	**Site:** Front St. Surficial	11/14/2017 1:34 PM	DW	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	3890 mg/L	11/15/2017
Chloride	SM 4500 Cl B	2210 mg/L	11/15/2017

Comment:

Reviewed by: ______________________

Analytical & Consulting Chemists

ENVIRONMENTAL CHEMISTS, INC

NCDENR: DWQ CERTIFICATION # 94 NCDHHS: DLS CERTIFICATION # 37729

6602 Windmill Way Wilmington, NC 28405
OFFICE: 910-392-0223 FAX 910-392-4424
info@environmentalchemists.com

COLLECTION AND CHAIN OF CUSTODY

Client: GMA-Greenville	**PROJECT NAME:** 160001	**REPORT NO:** 17-17622
ADDRESS: 4300 SAPPHIRE CT., SUITE 100	**CONTACT NAME:** JAY HOLLY	**PO NO:**
GREENVILLE, NC 27834	**REPORT TO:** JAY HOLLEY	**PHONE/FAX:** 252-752-3310
	COPY TO: . Kelley Smith	**email:** Jay@gma-nc.com

Sampled By:

SAMPLE TYPE: I = Influent, E = Effluent, W = Well, ST = Stream, SO = Soil, SL = Sludge, Other:

Sample Identification	Collection			Sample Type	Composite or Grab	Container (P or G)	Chlorine mg/L	LAB ID NUMBER	PRESERVATION							ANALYSIS REQUESTED
	Date	Time	Temp						NONE	HCL	H2SO4	HNO3	NAOH	THIO	OTHER	
SOUTHPORT SURFICIAL	11.14.17	1002			C	P		42689								
					G	G			X							TDS, Chloride (SM4500 Cl-B & E)
FT. FISHER SURFICIAL		1102			C	P		42690								
					G	G			X							TDS, Chloride (SM4500 Cl-B & E)
FRONT ST. PEEDEE		1305			C	P		42691								
					G	G			X							TDS, Chloride (SM4500 Cl-B & E)
FRONT ST. FLUVIAL		1326			C	P		42692								
					G	G			X							TDS, Chloride (SM4500 Cl-B & E)
FRONT ST. SURFICIAL					C	P		42693								
	11.14.17	1334			G	G			X							TDS, Chloride (SM4500 Cl-B & E)
					C	P										
					G	G			X							TDS, Chloride (SM4500 Cl-B & E)
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										

Transfer	Relinquished By:	Date/Time	Received By:	Date/Time
1.				
2.				

Temperature when Received:____ **Accepted:**____ **Rejected:**____ **Resample Requested:**____

Delivered By:____ **Received By:**____ **Date:** 11/14/17 **Time:** 1400

Comments:____ **TURNAROUND:**____

envirochem

Environmental Chemists, Inc.

6602 Windmill Way, Wilmington, NC 28405 • 910.392.0223 Lab • 910.392.4424 Fax
710 Bowsertown Road, Manteo, NC 27954 • 252.473.5702 Lab/Fax
255-A Wilmington Highway, Jacksonville, NC 28540 • 910.347.5843 Lab/Fax

ANALYTICAL & CONSULTING CHEMISTS

info@environmentalchemists.com

Groundwater Management Associates
4300 Sapphire Ct, Suite 100
Greenville NC 27834
Attention: Jay Holley

Date of Report: Sep 28, 2017
Customer PO #:
Customer ID: 09030031
Report #: 2017-13314
Project ID: 160001

Lab ID	**Sample ID:**	**Collect Date/Time**		**Matrix**	**Sampled by**
17-31911	**Site:** Ft. Fisher Peedee MW	8/31/2017	3:45 PM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	1220 mg/L	09/06/2017
Chloride	SM 4500 Cl E	525 mg/L	09/13/2017

Lab ID	**Sample ID:**	**Collect Date/Time**		**Matrix**	**Sampled by**
17-31912	**Site:** Ft. Fisher Castle Hayne MW	9/1/2017	1:30 PM	Water	Client

Test	**Method**	**Results**	**Date Analyzed**
Total Dissolved Solids (TDS)	SM 2540 C	22200 mg/L	09/06/2017
Chloride	SM 4500 Cl E	9440 mg/L	09/13/2017

Comment:

Reviewed by: ______________________

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COLLECTION AND CHAIN OF CUSTODY

Client: GWA	**PROJECT NAME:** 160001-	**REPORT NO:** 17-13314
ADDRESS: 4300 SAPPHIRE CT., STE. 100	**CONTACT NAME:** JAY HOLLEY	**PO NO:**
GREENVILLE NC 27834	**REPORT TO:** JAY HOLLEY	**PHONE/FAX:**
	COPY TO: Kelley Smith	**email:**

Sampled By:______

SAMPLE TYPE: I = Influent, E = Effluent, W = Well, ST = Stream, SO = Soil, SL = Sludge, Other:

Sample Identification	Collection			Sample Type	Composite or Grab	Container (P or G)	Chlorine mg/L	LAB ID NUMBER	PRESERVATION							ANALYSIS REQUESTED
	Date	Time	Temp						NONE	HCL	H2SO4	HNO3	NAOH	THIO	OTHER	
FT. FISHER PEEDEE MW	8-31-17	3:45pm			C	P		31911								Cl^- & TDS
					G	G										
FT. FISHER CASTLE HAYNE MW	9-1-17	1:30pm			C	P		31912								Cl^- & TDS
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										

Transfer	Relinquished By:	Date/Time	Received By:	Date/Time
1.	Kelly A.	9-4-17		9-5 0716
2.				

Temperature when Received: 1.6 **Accepted:** ✓ **Rejected:**______ **Resample Requested:**______

Delivered By:______ **Received By:** R. K **Date:** 9-5-17 **Time:** 1545

Comments:______ **TURNAROUND:**______

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Environmental Chemists, Inc.

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255-A Wilmington Highway, Jacksonville, NC 28540 • 910.347.5843 Lab/Fax

info@environmentalchemists.com

Groundwater Management Associates
4300 Sapphire Ct, Suite 100
Greenville NC 27834
Attention: Kelley Smith

Date of Report: May 02, 2017
Customer PO #:
Customer ID: 09030031
Report #: 2017-05810
Project ID: 160001

Lab ID	Sample ID:	Collect Date/Time	Matrix	Sampled by
17-13745	**Site:** CHA-MW-Southport	4/25/2017 3:30 PM	Water	Client

Test	Method	Results	Date Analyzed
Total Dissolved Solids (TDS)	SM 2540 C	196 mg/L	04/27/2017
Chloride	SM 4500 Cl E	21 mg/L	04/27/2017

Lab ID	Sample ID:	Collect Date/Time	Matrix	Sampled by
17-13750	**Site:** PD-MW-Southport	4/26/2017 1:40 PM	Water	Client

Test	Method	Results	Date Analyzed
Total Dissolved Solids (TDS)	SM 2540 C	305 mg/L	04/27/2017
Chloride	SM 4500 Cl E	59 mg/L	04/27/2017

Comment:

Reviewed by: Mariola Olejarz

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Analytical & Consulting Chemists

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6602 Windmill Way Wilmington, NC 28405
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COLLECTION AND CHAIN OF CUSTODY

Client: GMA	**PROJECT NAME:** 160001	**REPORT NO:** 17- 05810
ADDRESS: 4300 SAPPHIRE CT STE100	**CONTACT NAME:** Kelly Smith	**PO NO:**
GREENVILLE NC 27834	**REPORT TO:** Kelly Smith	**PHONE/FAX:**
	COPY TO: JAY HOLLEY	**email:**

Sampled By:______

SAMPLE TYPE: I = Influent, E = Effluent, W = Well, ST = Stream, SO = Soil, SL = Sludge, Other:

Sample Identification	Collection			Sample Type	Composite or Grab	Container (P or G)	Chlorine mg/L	LAB ID NUMBER	PRESERVATION							ANALYSIS REQUESTED
	Date	Time	Temp						NONE	HCL	H2SO4	HNO3	NAOH	THIO	OTHER	
CHA MW SOUTH PORT	4.25.17	1530			C	P		13745								TDS/Cl-
					G	G										
PD MW SOUTHPORT	4.26.17	1340			C	P		13750								TDS/Cl-
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										
					C	P										
					G	G										

Transfer	Relinquished By:	Date/Time	Received By:	Date/Time
1.	Kelly A. Smith	4.26.17		
2.				

Temperature when Received: 0.9 **Accepted:** — **Rejected:**______ **Resample Requested:**______

Delivered By:______ **Received By:**______ **Date:** 4/26/17 **Time:** 7:30 Am

Comments:______ **TURNAROUND:**______

Appendix V

Survey Data

CHARLES F. RIGGS & ASSOCIATES, INC.
Land Surveyors

Charles F. Riggs, P.L.S. L-2981
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charlesriggs@riggslandnc.com

Corporate License (C-730)
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James A. Lewis, P.L.S. L-4562
Landfall Executive Suites
1213 Culbreth Drive
Wilmington, North Carolina 28405
(910) 681-7444
jameslewis@riggslandnc.com

Monitoring Well Report
Groundwater Management Associates, Inc.
Riggs Project Number: 17-10-31

Site #1 – Wilmington Port

Surficial (Riggs 1C)	N: 171,743.06’	E: 2,317,111.51’	Elev: 6.84’
Fluvial Sand (Riggs 1B)	N: 171,746.55’	E: 2,317,139.93’	Elev: 6.80’
Peedee (Riggs 1A)	N: 171,750.26’	E: 2,317,163.86’	Elev: 6.96’

Site #2 – Fort Fisher Ferry Landing

Surficial (Riggs 2B)	N: 78,702.94’	E: 2,321,843.77’	Elev: 13.17’
Castle Hayne (Riggs 2A)	N; 78,688.93’	E: 2,321,857.38’	Elev: 12.50’
Peedee (Riggs 2C)	N: 78,724.48’	E: 2,321,825.36’	Elev: 12.74’

Site #3 – Southport

Surficial (Riggs 3A)	N: 73,455.68’	E: 2,307,693.19’	Elev: 26.92’
Castle Hayne (Riggs 3B)	N: 73,468.97’	E: 2,307,707.39’	Elev: 27.00’
Peedee (Riggs 3C)	N: 73,485.39’	E: 2,307,718.58’	Elev: 27.36’

The above monitoring wells were located using Topcon Hiper SR Rover and NC CORS on March 26, 2018. The above coordinates are referenced to NAD83(2011), elevation datum is NAVD88.

James A. Lewis
James A. Lewis, PLS L-4562

SEAL
L-4562
JAMES A. LEWIS

Appendix E–2:
Groundwater Modeling Simulations

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GROUNDWATER MODELING SIMULATIONS OF THE WILMINGTON PORT EXPANSION

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

GMA Project #160001

Prepared for

Moffatt & Nichol
4700 Falls of Neuse Road, Suite 300
Raleigh, NC 27609

Prepared By:

Groundwater Management Associates, Inc.
4300 Sapphire Court, Suite 100
Greenville, North Carolina 27834

SEAL 2369 2/15/19
EMMA HARDISON SHIPLEY

North Carolina Corporate Geology License #: C-121

February 15, 2019

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EXECUTIVE SUMMARY

The North Carolina State Ports Authority (NCSPA) is performing a Section 203 study to assess the feasibility of deepening the federal Wilmington Harbor channel. The study will assess the existing conditions, future without project conditions, and depths that are economically justified. Based on analyses by others, only one depth, -47 ft Mean Lower Low Water (MLLW), is justifiable and carried forward in the study; therefore our evaluation used this proposed depth.

Channel improvements will extend from the Port downstream to a position approximately 10 miles offshore. Groundwater Management Associates, Inc. (GMA) has developed a three-dimensional, steady-state, seven-layer groundwater flow model to evaluate the potential effects of the proposed deepening on regional and local groundwater flow patterns and the potential for saltwater intrusion into fresh water aquifers. The groundwater flow model was constructed using the Groundwater Modeling System interface (GMS 10.3.7) with the United States Geological Survey (USGS) groundwater model, MODFLOW-NWT. MODFLOW is a modular, three-dimensional groundwater-flow model code that simulates groundwater flow using a finite-difference method applied to a block-centered rectangular grid.

Previous channel modifications for the Port of Wilmington were modeled by Jeff Lautier with the North Carolina Department of Environment and Natural Resources, Division of Water Resources (Lautier, 1998) using the 3D finite element model, FEMWATER. GMA initially attempted to update the original FEMWATER model to simulate the proposed channel modifications. Due to the age of the NCDWR model, software changes over the last 10 years, and limitations of the original modeling code, this effort proved unsuccessful. GMA then constructed and calibrated a finite difference MODFLOW model to encompass the area potentially affected by the proposed channel modifications. This modeling effort has incorporated the results of field exploration and data collection, aquifer testing, groundwater-level monitoring, as well as geographic and geologic data.

The focus of the modeling program was to evaluate the potential for saltwater intrusion into the groundwater system as a result of deepening and widening of the existing Cape Fear River channel. GMA's model predicts hydraulic head in four aquifers potentially affected by the channel deepening – the Surficial, the Castle Hayne, the Upper Peedee, and the Lower Peedee - under steady state conditions based on regional water-level information from 2017. Below is a summary of model parameters and assumptions, model calibration, and simulations of the effects of channel improvements on the groundwater system.

Model Assumptions

- The model area covers 1,134 square miles and encompasses most of New Hanover and Brunswick Counties.

- Grid cell dimensions are 1000 feet by 1000 feet (almost 23 acres per cell).
- The model includes 7 layers that simulate the Surficial Aquifer (SA), the Castle Hayne Confining Layer (CHCL), the Castle Hayne Aquifer (CHA), the Upper Peedee Confining Layer (UPCL), the Upper Peedee Aquifer (UPDA), the Lower Peedee Confining Layer (LPCL), and the Lower Peedee Aquifer (LPDA). These layers represent all hydraulic units that are locally in contact with, or are hydraulically influenced by, the Cape Fear River channel. In addition, the model includes a deeper aquifer (the LPDA) that is not hydraulically influenced by the Cape Fear River Channel.
- The model area encompasses the region and layers modeled by the NCDWR in 1998. The NCDWR framework study and model assumptions were the foundation of the input parameters incorporated by GMA into the MODFLOW model.
- The NCDWR model framework and input assumptions were updated to incorporate results from drilling at three new monitoring well stations adjacent to the Cape Fear River channel. The framework was further modified to incorporate subdivisions of the Peedee Aquifer into upper and lower units based upon available new data from other regional drilling programs. GMA's model also incorporated updated data (since 1998) on expanded groundwater usage within the model domain.
- Moffatt & Nichol provided the existing channel dimensions and river bathymetry from the Wilmington Harbor Deepening Survey of 2018. The channel is currently 42 feet deep relative to Mean Lower Low Water (MLLW).
- Channel modifications within the model were based upon a proposed deepening to a 47-foot deep channel relative to MLLW level. This channel depth was provided by Moffatt & Nichol as the selected channel modification. To simulate channel deepening, GMA modified grid elevations within the channel to match the proposed 47-foot deep channel.
- GMA calibrated the model relative to available water-level data from 2017.
- Hydraulic boundaries assigned to the model included:
  - Ocean set constant at zero (feet MSL).
  - Cape Fear River set constant at zero (feet MSL).
  - Intracoastal Waterway set constant at zero (feet MSL).
  - General head boundaries established along the western and northern margins of the model area and along the shoreline (for the LPDA) to account for hydraulic influence of areas outside the model domain.
  - Drains were incorporated along major streams to simulate loss of groundwater to local discharge features (such as creeks, rivers, and swamps) within the model domain.

Model Calibration

GMA adjusted recharge rates, hydraulic conductivities, and boundary conditions to achieve a close match of simulated heads with observed head data from 2017. Most adjustments were made manually to establish a close correlation between known hydraulic data and model assigned properties. Final calibration was accomplished using PEST, a model-independent parameter estimation and uncertainty analysis, to achieve an optimal match between known and simulated head values. All recharge and hydraulic conductivity values were within the range of published values for the model domain. A comparison between modeled and observed groundwater levels indicate a good fit ($r^2 = 0.98$). We achieved a mean absolute residual error of 1.61 feet and a root mean squared residual of 2.07 feet.

Baseline Simulations of Existing Conditions

A baseline groundwater flow model was initially developed using current channel geometry to simulate existing conditions. Results from the model of existing conditions indicates the following:

- The Cape Fear River serves primarily as a discharge area for the Surficial Aquifer. Heads in the Surficial Aquifer adjacent to the river channel are higher than the head in the River, and groundwater flow is toward the River.
- The Cape Fear River also acts as a discharge area for both the Castle Hayne and the Upper Peedee Aquifers except in local areas where production well pumping has depressurized those units.
- The Upper Peedee Aquifer is unconfined throughout much of the western portion of the model domain, and groundwater flow patterns within this unit mimic the patterns seen in the Surficial Aquifer.
- The Lower Peedee Aquifer is well-confined, and it appears to be uninfluenced by the Cape Fear River channel.
- Model simulations show two areas relatively close to the dredge channel where groundwater pumping has lowered groundwater heads beneath sea level. This pumping has created the *potential* for surface water to migrate downward into the groundwater system. Two identified areas proximal to the navigation channel have a downward-directed head potential. These areas include Southport in the vicinity of the Capital Power Corporation withdrawal, and the area near Carolina Beach and Kure Beach water-supply wells.
- Model results indicate that the cone of depression from the Capital Power Corporation withdrawal from the Upper Peedee Aquifer extends beneath the Cape Fear River. However, the Upper Peedee Aquifer is well confined in this region, and any downward migration of surface water would be slow. The newly constructed monitoring well station at Southport includes an Upper Peedee Aquifer monitoring well placed adjacent to the Cape Fear River, between the river channel and the Capital Power Corporation wellfield. Groundwater heads in this monitoring well are consistently about 4 feet below mean sea level as a result of pumping from the Capital Power Corporation wellfield. Despite the downward directed head gradient relative to the River, groundwater samples collected from this well are fresh, which suggests that the UPDA is well

confined in this region. Furthermore, tidal variation of water levels in the UPDA monitoring well is muted, indicating that the aquifer is not directly connected to tidal surface water in the Cape Fear River.

- The Carolina Beach wellfield exists in close proximity to a paleochannel where erosion has removed the Castle Hayne Confining Layer, thereby exposing the Castle Hayne Aquifer to enhanced local recharge from the Surficial Aquifer. This paleochannel was described by the US Geological Survey (Bain, 1970), and the feature was incorporated into the NCDWR model (Lautier, 1998) and into the current MODFLOW model. The lack of effective confinement of the Castle Hayne Aquifer near Carolina Beach makes the area vulnerable to saltwater intrusion from the ocean and from the Cape Fear River. Furthermore, this region also exhibits thinning or absence of the confining layer between the Castle Hayne and the Upper Peedee Aquifers. Groundwater withdrawals from the Upper Peedee and Castle Hayne Aquifers at Carolina Beach and at Kure Beach have locally lowered the potentiometric surfaces within these aquifers to below sea level, thereby allowing water from the Surficial Aquifer, and from adjacent surface water bodies (the Ocean and the Cape Fear River), to move downward into the Castle Hayne and Peedee Aquifers. Existing localized saltwater intrusion in the vicinity of Carolina Beach has been an ongoing challenge to the Carolina Beach public water system (GMA, 2007). Our groundwater flow model predicts groundwater levels below sea level in the vicinity of Carolina Beach. This prediction is consistent with existing known saltwater intrusion issues. The area of saltwater intrusion potential near Carolina Beach is intrinsic to the existing geological conditions (i.e., poor confinement of the Castle Hayne and Upper Peedee Aquifers) and to the groundwater withdrawal patterns that have lowered the equipotential surface below sea level. The existing localized saltwater intrusion issues at Carolina Beach appear to be unrelated to the existing navigation channel of the Cape Fear River, because the depressurization below sea level does not extend beneath the current river to the navigation channel position.

Simulations of Projected Sea Level Rise and Channel Modifications

GMA used bathymetry data for the planned 47-foot deep channel improvement provided by Moffatt & Nichol to adjust the elevation of the top of layer one in the calibrated groundwater flow model. GMA identified areas where the projected channel deepening would incise into a different aquifer or confining unit. GMA changed the model parameters in those model cells, as appropriate, to reflect the direct connection between the deepened channel with the newly exposed aquifer or confining layer materials. GMA then re-ran the calibrated model to evaluate the effects of the channel deepening. To evaluate the potential effects of sea-level rise, GMA also performed simulations of both the existing and the modified channel geometry under a projected 2.56 foot rise in sea level. This corresponds to the Army Corps of Engineers' "high" estimate for projected sea-level rise for the year 2077 (50 years after construction is completed). GMA's groundwater simulations of the modified channel and sea-level rise effects indicate the following:

- The proposed channel deepening project does not significantly influence groundwater flow patterns. In fact, groundwater flow patterns for all four modeled aquifers (SA, CHA, UPDA, and the LPDA) were virtually identical under the proposed channel modification simulations.
- The proposed channel deepening adjacent to Southport does not breach or thin the Upper Peedee Confining Layer, and therefore the proposed channel does not increase the potential for saltwater intrusion into the Upper Peedee Aquifer in that area. Model simulations reveal no effect on the groundwater flow patterns near Southport in response to proposed channel modifications.
- Simulations also indicate that the planned channel improvement will not increase the potential for saltwater migration in the vicinity of the Carolina Beach or Kure Beach municipal water-supply wells. The predicted depressurized area around these well fields impinges upon the shoreline of the Cape Fear River, but does not extend to the navigational channel, located more than a mile away on the west side of the river. If future groundwater withdrawals from this area are excessive, especially from wells placed closest to the river, salinity may increase as salty surface water migrates towards the wellfield. Model results suggest, however, that the channel deepening is too far removed from the pumping wells at Carolina Beach and Kure Beach to affect saltwater intrusion in this semiconfined area.
- Simulations for sea level rise, both with and without channel modifications, showed very little changes to the patterns of groundwater flow and discharge. Model results suggest that sea-level rise will not increase the potential for saltwater intrusion associated with proposed channel modifications.

In summary, groundwater modeling indicates that the proposed channel modifications will not increase the potential for saltwater intrusion above what currently exists within the system. Modeling indicates that the cone of depression from pumping in the Southport area extends beneath the Cape Fear River, and this pumping has created the *potential* for downward migration of salty surface water into the Upper Peedee Aquifer. Importantly, however, the Upper Peedee Aquifer in this area is well confined, and the aquifer exists approximately 50 feet *below* the proposed channel bottom. Thus, the proposed channel deepening near Southport would not impact the degree of confinement of the Upper Peedee Aquifer beneath the channel. Likewise, the proposed channel modifications near Carolina Beach are not projected to affect the potential for saltwater intrusion in that area. The naturally poor confinement of the Castle Hayne and Peedee Aquifers near Carolina Beach, and the existing groundwater withdrawal conditions have resulted in localized saltwater intrusion under existing conditions. Model results indicate that the proposed channel modifications do not alter these existing groundwater conditions.

1.0 INTRODUCTION

North Carolina State Ports Authority (NCSPA) is performing a Section 203 study to assess the feasibility of deepening the federal Wilmington Harbor channel that connects the Atlantic Ocean from the mouth of the Cape Fear River to the Port of Wilmington. The study will assess the existing conditions, future without project conditions, and depths that are economically justified. Based on analyses by others, only one depth, -47 ft Mean Lower Low Water (MLLW), is justifiable and carried forward in the study; therefore, our evaluation used this proposed depth.

The proposed channel improvements will entail widening, as well as deepening of the shipping channel to accommodate larger ships in the port. Groundwater Management Associates, Inc. (GMA) was contracted by Moffatt & Nichol to provide a hydrogeologic evaluation of the potential for saltwater intrusion as a result of removing sediments from beneath the channel.

GMA's study included two phases of work: 1) supplemental groundwater data collection and site conceptual model development, and 2) groundwater computer modeling. GMA developed a conceptual model of the system and completed phase I of this work in April of 2018 (GMA, 2018), and the reader is referred to that report for details of hydrogeologic setting and conceptual model development. This report provides modeling predictions of groundwater flow patterns and recharge/discharge relationships between the Cape Fear River and the adjacent groundwater system. Simulations include current navigation channel configuration, proposed deepening and widening of the navigation channel, and evaluations of potential sea-level rise for both navigation channel scenarios.

2.0 BACKGROUND

In 1998, the North Carolina Department of Environment, Health, and Natural Resources, Division of Water Resources (NCDWR) developed a hydrogeologic assessment and groundwater model to evaluate the effects of deepening the Wilmington Harbor shipping channel by 5 feet (Lautier, 1998). The NCDWR groundwater flow model employed the FEMWATER program, developed by the U.S. Army Waterways Experiment Station-Hydraulics Lab (Yeh, 1987; Lin et al., 1997). FEMWATER (Finite Element Model of Water Flow through Saturated-Unsaturated Media) is a 3D finite element, density driven, flow and transport model that can be used to simulate flow and transport in both the saturated and the un-saturated zones. NCDWR used the preprocessor/postprocessor called Groundwater Modeling System (GMS) to facilitate construction and operation of their groundwater flow model. GMS is a graphical user interface that facilitates model design and parameter input for programming various groundwater models.

The basis of the NCDWR model grid and input parameters was a Hydrogeologic Framework Study performed by NCDWR that encompassed Brunswick and New Hanover counties. The framework study provided details of hydrostratigraphy, aquifer hydraulic properties, and hydraulic head for the primary aquifer units that occur in the region (Lautier, 1998). The calibrated groundwater flow model was then used to perform simulations of groundwater conditions following a proposed 5-foot deepening of the channel. The NCDWR groundwater model demonstrated that the aquifer system maintained a discharge relationship to the Cape Fear River and the shipping channel, both before and after simulated 5-foot deepening of the channel. Under this relationship, fresh groundwater from the adjacent aquifer system flows toward, and discharges into, the more saline Cape Fear River, and not vice versa. In other words, the NCDWR model indicated that deepening of the channel was not expected to induce saltwater intrusion into the adjacent and underlying aquifers.

The channel was deepened after completion of the NCDWR study, and current dredging activities maintain the channel to at least a depth of 42 feet (referenced to mean lower low water [MLLW]) with an over-dredge allowance of 2 feet from Anchorage Basin to Lower Swash and a depth of 44 feet (MLLW) with an over-dredge allowance of 2 feet from Battery Island to Baldhead Shoal Reach 3 (Fugro, 2018). The NCSPA is again planning to deepen, widen, and/or realign the existing navigation channel. Current plans are to deepen the channel to a depth of 47 feet (MLLW) for the Lower Swash Reach and all reaches up-river from there and to a depth of 49 feet below the Lower Swash Reach in areas affected by ocean waves (Fugro, 2018, Fugro 2018a). For simplification, we refer to this proposed design as the 47-foot channel depth. GMA was contracted to provide updated groundwater modeling of the area to evaluate the possible effects of the proposed channel improvements.

3.0 REGIONAL HYDROGEOLOGIC SETTING

The Cape Fear River Navigation Channel (Figure 1) lies within the Coastal Plain Physiographic Province of North Carolina (NCGS, 1985). North Carolina's Coastal Plain is a broad, relatively flat physiographic province separating the hilly Piedmont province from the Atlantic Ocean. Local elevation ranges from about 70 feet above sea level (ASL) in upland areas west of the Cape Fear River and about 60 feet at Wilmington east of the river down to sea level. Land surface topography in the study area is primarily a product of Neogene and Quaternary fluctuations in sea level that repeatedly inundated and exposed the land over the past 23 million years (Harris and Zullo, 1991). These sea-level cycles sculpted the land surface into broad, relatively flat marine terraces bounded by low escarpments that represent former shorelines. Streams and rivers have incised these terraces to create the current topographic character of the area. Local stream positions and drainage patterns are strongly influenced by near-surface geologic units, especially the locations of indurated rock. GMA previously detailed the regional hydrogeologic setting in our phase I report (GMA, 2018). In the interest of brevity, this section of the report will only present concise summaries of important aspects of the regional hydrogeologic setting.

3.1 Regional Geology

The Coastal Plain Province is underlain by marine, estuarine, and terrestrial sediments that were deposited along the continental margin over the past 200 million years. The strata exposed along the Cape Fear River are comprised of Mesozoic to Recent-aged sediments of dominantly marine origin. These units include the Cretaceous Peedee Formation, the Eocene Castle Hayne Formation, and unnamed Pleistocene to Recent surficial sediments. These sedimentary strata are the framework for important regional aquifers and confining units. Table 1 presents the ages and formation names of stratigraphic units that occur beneath the study area.

Table 1. Hydrostratigraphic Units in New Hanover and Eastern Brunswick Counties

GEOLOGIC UNITS			HYDROGEOLOGIC UNITS
SYSTEM	SERIES	FORMATION	AQUIFERS AND CONFINING LAYERS
Quarternary	Holocene	Surficial sand deposits	Surficial Aquifer
	Pleistocene	Undifferentiated Pleistocene and Pliocene deposits	
Tertiary	Pliocene		Tertiary Aquifer and Confining Layer
	Oligocene	River Bend Formation[1]	
			Castle Hayne Confining Layer
	Eocene	Castle Hayne Formation[2]	Castle Hayne Aquifer
	Paleocene	Beaufort Formation[3]	
			Upper Peedee Confining Layer
Cretaceous	Upper Cretaceous	Peedee Formation *Rocky Point Member* *Lower Peedee Units*	Upper Peedee Aquifer Lower Peedee Confining Layer Lower Peedee Aquifer
			Black Creek Confining Layer
		Black Creek and Middendorf Formations	Black Creek Aquifer
			Upper Cape Fear Confining Layer
		Cape Fear Formation	Upper Cape Fear Aquifer
			Lower Cape Fear Confining Layer
			Lower Cape Fear Aquifer
Pre-Cretaceous basement rocks			

[1] Presence limited to southern New Hanover County (Zarra, 1991).

[2] Presence limited to southern and eastern New Hanover County and southeastern Brunswick County (Zarra, 1991).

[3] Presence limited to southern New Hanover County and southeastern Brunswick County (Zarra, 1991).

3.2 Hydrogeologic Units

The hydrostratigraphic units that comprise the aquifers and confining layers beneath southern New Hanover and eastern Brunswick Counties are summarized in Table 1. These aquifer names are consistent with hydrostratigraphic nomenclature used by NCDWR (Lautier, 1998 and 2006) and the United States Geological Survey (USGS) (Winner and Coble, 1996), with the exception that we have subdivided the Peedee into two separate aquifers, as described later in this section. The confining layers separating aquifers in southern New Hanover and eastern Brunswick Counties vary in their ability to restrict inter-aquifer flow. Very low permeability units are often comprised of clay, and thick sequences of clay (e.g., the Black Creek Confining Layer) locally separate fully-confined aquifers. In contrast, some confining layers are comprised of low- to moderate-permeability sediments (e.g., silty sand) that cannot yield significant quantities of water to pumping wells, yet these sediments still allow significant vertical movement of water between aquifers. In southern New Hanover and eastern Brunswick Counties, these leaky or "semi-confining" layers typically occur between Cenozoic-age aquifers (e.g., the Castle Hayne Confining Layer).

Because Lautier performed a comprehensive framework study of the aquifers and confining units that are, or may be, hydraulically connected to the Cape Fear River channel in the region, GMA has accepted Lautier's hydrostratigraphic framework as the foundation of our groundwater flow modeling. However, we also include a subdivision of the Peedee Aquifer into three hydraulic units: the Upper Peedee Aquifer, the Lower Peedee Confining Layer, and the Lower Peedee Aquifer.

Recent studies of the Peedee Aquifer at Leland (GMA, April 30, 2015) and Shallotte (GMA, July 27, 2016) in Brunswick County, and at the Cape Fear Public Utility Authority ASR well at Wilmington (GMA, 2006), have identified distinctive upper and lower units of the Peedee Aquifer. The Upper Peedee Aquifer is a significant source of fresh water supply in the region, and the aquifer is comprised predominantly of calcareous sandstone and sandy limestone of the Rocky Point Member of the Peedee Formation. The lower Peedee Confining Layer is sandy clayey silt to silty clay with occasional sandstone beds that occurs beneath the Rocky Point Member. The Lower Peedee Aquifer is composed of unconsolidated fine to medium sands that contain brackish groundwater throughout the region. The Lower Peedee Confining Layer provides significant confinement between the Upper and Lower Peedee Aquifers, and there are significant differences in head and water quality above and below the Lower Peedee Confining Layer. Therefore, GMA's model has incorporated this new regional hydrostratigraphy data for the Peedee Aquifer.

4.0 FEMWATER MODELING ATTEMPT

Because the previous modeling performed by NCDWR was suitable for evaluation of the previous channel improvements, GMA initially attempted to update and recalibrate the original 1998 NCDWR FEMWATER model in GMS (Groundwater Modeling System, GMS 10.3.7). The purpose of the model update was to include additional groundwater withdrawals that were not present in 1998 and to match the current channel configuration. Due to the age of the NCDWR model, software changes over the last 10 years, and limitations of the original modeling code, this effort proved unsuccessful. GMA successfully built a 3D finite element mesh based on the NCDWR model, but the original FEMWATER code was limited by the number of pumping wells that could be simulated. The additional pumping wells could not be added to the model without changing model parameters within the FORTRAN code and recompiling the program. We were able to successfully recompile the program to incorporate the expanded groundwater withdrawals. We then encountered a FEMWATER code issue that could not be worked around, and the model would not run. FEMWATER was last released in 2001 and is no longer in development. GMS support personnel and programmers could also not work around the FEMWATER code issue encountered by GMA, and after much effort, the model was abandoned.

5.0 MODFLOW-NWT MODELING

After the failed FEMWATER modeling attempt, GMA then developed and calibrated a steady-state, three-dimensional MODFLOW-NWT groundwater model using GMS software to simulate groundwater flow in the vicinity of the proposed channel deepening project. This MODFLOW-based model was built using the NCDWR model parameters and layer elevations as a base. MODFLOW is a modular, three-dimensional groundwater-flow model code developed by the United States Geological Survey (USGS) that simulates groundwater flow using a finite-difference method applied to a rectangular grid. Specifically, GMA used MODFLOW-NWT, a version of MODFLOW based on MODFLOW-2005 that works well for unconfined aquifers.

GMA’s modeling effort has adapted and expanded the stratigraphy and assumptions of the NCDWR model to reflect current conditions within the region, and we incorporated the results of recent field exploration and data collection, aquifer testing, and groundwater-level monitoring, as well as geographic and geologic data. Although there are some differences between the NCDWR model, which used a finite element mesh, and our grid-based MODFLOW model, GMA’s model was based on the hydrostratigraphic framework developed by NCDWR and the locations and elevations of aquifer units and confining layers are the same for areas where the two models overlap. Additionally, the MODFLOW model developed by GMA required expanding the model area, which allowed us to better incorporate expanded groundwater utilization within the region.

Transient models are useful for evaluating water-level responses to daily or seasonal changes in pumping rates, or for predicting the time component of transport of contaminants from a source area (Anderson et al., 2015). The potential for intrusion of salty surface water due to widening and deepening of the Wilmington Harbor channel is ultimately dependent on groundwater recharge and discharge relationships with the Cape Fear River, not short-term changes due to daily fluctuations in pumping rates. The modeling effort by the NCDWR previously concluded that the aquifer system maintained a discharge relationship with the Cape Fear River and that dredging would not cause any short-term changes to aquifer water levels. Therefore, GMA chose to model this system under steady-state conditions, which allowed GMA to evaluate whether any changes to the groundwater discharge relationship with the river are the result of additional groundwater withdrawals in the region. GMA believes that a steady-state model satisfies the modeling objectives in this situation.

Lautier's previous modeling results indicated that channel deepening would not induce changes in hydraulic head values, and thus, would not alter the advection processes that control the fresh water / salt water interface (Lautier, 1998). Therefore, Lautier did not proceed with modeling solute (i.e., saltwater) transport processes. GMA approached the current modeling effort using the same assumption that advection controls migration potential of saline water in the groundwater system.

The purpose of this report section is to describe the development, calibration, and application of the MODFLOW model to evaluate potential effects of the proposed channel deepening. Specifically, GMA performed model simulations to:

- Calibrate to recent (2017) groundwater-flow conditions in the region of the proposed Cape Fear River Navigation Channel deepening project,
- Simulate the impacts on groundwater flow of deepening the Cape Fear River Navigation Channel,
- Evaluate the potential for saltwater intrusion due to channel deepening

GMA's model predicts hydraulic head in four aquifers potentially affected by the channel deepening (the Surficial, the Castle Hayne, the Upper Peedee, and the Lower Peedee) under steady-state conditions based on regional water-level information from 2017. Table 2 lists a summary of the assumptions and design elements used to develop the model.

Table 2. Summary of the Model Design and Assumptions

Parameters	Design and Assumptions
Area	Area surrounding the Port of Wilmington channel deepening project potentially impacted by channel deepening (see Figure 1)
Code & Solver	MODFLOW-NWT – UPW flow package, NWT solver with GMS 10.3.7
Calibration Period	Steady state model calibrated to average 2017 head values
Dimensions & Orientation	Model origin: x= 2,201,000, y = 61,000 (NAD83 State Plane NC - Feet) X extent: 155,000 ft Y extent: 204,000 ft Grid rotated 15° east consistent with predominant flow directions.
Grid Spacing	204 rows & 155 columns (Figure 2) Cell size: 1000 ft x 1000 ft
Layers	7 layers: Surficial aquifer (SA), Castle Hayne Confining Layer (CH-CL), Castle Hayne Aquifer (CHA), Upper Peedee Confining Layer (UPD-CL), Upper Peedee Aquifer (UPDA), Lower Peedee Confining Layer (LPD-CL), and Lower Peedee Aquifer (LPDA) (Figures 3-5)
Surfaces	Based on the 1998 NCDWR model (Figure 6), NCDWR well logs, and project specific borehole data
BOUNDARIES	
No-flow Boundaries	Unless otherwise specified, model extents were left as no flow boundaries by default.
Groundwater Recharge	Range of recharge used in the model: 0.0001 ft/day to 0.0040 ft/day (0.44 in/yr to 17.52 in/yr). All recharge applied to the top of layer 1. Recharge details shown in Figure 7.
General Head	A general head boundary (GHB) was used in the SA (Layer 1) to simulate the Boiling Spring Lakes. GHBs were set in the Lower Peedee Aquifer (Layer 7) based on regional groundwater contouring available from the NCDWR website for 2017 (NCDWR, 2018). Locations of GHBs are shown in Figure 8.
Constant Head	Constant head cells were used to model heads in the Atlantic Ocean, the Intracoastal Waterway, and in the Cape Fear River (Figure 9).
Drains	Drain cells were used to model the creeks and streams through the model area (Figure 9). Drain cell elevations were assigned based on topographic data.
Pumping Wells	Pumping well data were gathered from the NCDWR website (NCDWR, 2018).

5.1 Grid and Layer Design

The study area is the Cape Fear River Navigation Channel which lies along the border of Brunswick and New Hanover Counties (Figure 1). The finite-difference method requires that the model be discretized horizontally into a two-dimensional grid (Figure 2) and vertically into layers (Figures 3-5), resulting in a three-dimensional array of cells known as the model grid. The rectangular MODFLOW-NWT model grid used by GMA encompasses the entire 1998 NCDWR model area (Figure 6) and covers more than 1130 square miles. The large areal extent of the model ensures that the simulation included any potential large-scale groundwater users than might influence groundwater flow patterns beneath the Cape Fear River.

GMA developed a 7-layer groundwater model that represents the units underlying the Cape Fear River Navigation Channel. Elevations for the top of each model layer were imported from the previous 1998 NCDWR model constructed by Lautier. These baseline elevations were refined through incorporation of the currently existing channel bathymetry (provided to GMA by Moffatt and Nichol) and new information from wells installed by GMA specifically for this project (GMA, 2018). In areas outside of the NCDWR model footprint, GMA used hydrogeologic data from the DWR online ground water database (https://www.ncwater.org/?page=20) to construct layer surfaces. The elevation of the land surface was based on the USGS 1/3 arc-second National Elevation Dataset available online (https://nationalmap.gov/elevation.html). Data were correlated to construct a three-dimensional representation of aquifers and confining units.

The seven hydrostratigraphic layers modeled are listed in Table 3. The model grid has 205 rows and 155 columns (Figure 2). The spatial discretization of the model grid determines the resolution. Due to the relatively narrow width of the navigation channel and its orientation relative to the model extent, GMA used a small, uniform grid cell size throughout the model. Cell dimensions are 1000 feet by 1000 feet (approximately 23 acres per cell). Principal grid axes (rotated 15^o east) align with the predominant groundwater flow direction and are generally parallel to the coast.

MODFLOW finite difference grids require that each model layer be continuous and exist throughout the model domain. This type of model grid system does not accommodate lateral pinching of aquifer units as well as finite element models, such as FEMWATER. However, tight grid refinement can help to address modelling challenges resulting from laterally discontinuous hydrostratigraphic layers. The small grid size used in GMA's model is much more detailed than the NCDWR's 3-D mesh used in the FEMWATER modeling (Lautier, 1998) to help address challenges of pinching model layers (Figure 6). To simulate the pinching and discontinuous nature of several of the hydrostratigraphic units within our model, material property parameters within layers were assigned based on the relevant hydrogeologic unit that would occupy that space. Therefore, some hydrostratigraphic units occupy more than one layer within the model (Table 3).

Table 3: Model Layers

Model Layers	**Hydrostratigraphic Unit**
Layer 1	Surficial Aquifer
Layers 1-2	Castle Hayne Confining Layer
Layers 1-3	Castle Hayne Aquifer
Layers 1-4	Upper Peedee Confining Layer
Layers 1-5	Upper Peedee Aquifer
Layer 6	Lower Peedee Confining Unit
Layer 7	Lower Peedee Aquifer

5.2 Model Boundaries

Boundary conditions are necessary to define how the model interacts both internally and with areas outside the model domain. Incorrectly assigned or unrealistic boundary conditions are often the greatest source of error in groundwater modeling. To minimize any potential errors in boundary specification, GMA utilized boundaries corresponding to natural physical boundaries, wherever possible. A summary of the boundaries specified in this model is provided below and boundaries are shown in Figures 8-9. Unless otherwise specified below, model extents were left as no flow boundaries by default. However, the extent of the model was chosen to be large enough so that model edge boundaries would only minimally affect the solutions for the area of interest. Assumptions used to construct the model boundaries are summarized in Table 2.

General Head Boundaries

GMA used general head boundaries (GHBs) to simulate lateral boundary flows to and from distant boundaries located outside of the model domain. GHBs are assigned by defining a hydraulic head and a conductance value. A GHB will transfer water to adjacent cells with different hydraulic head, based on the hydraulic head assigned to the boundary and a threshold conductance. The flow to adjacent cells is not allowed to exceed the conductance of the general head boundary.

A GHB was used in the Surficial Aquifer layer (Layer 1) to simulate Boiling Springs Lakes, an impounded lake complex that serves as a known recharge area for the Castle Hayne Aquifer. GHBs were set in the Lower Peedee Aquifer (Layer 7) based on regional groundwater contouring available from the NCDWR Ground Water Management Branch Map Interface for 2017 (NCDWR, 2018) and estimated outcropping distances for the unit off shore. Locations of GHBs are shown in Figure 8.

Drains

The Upper Peedee Aquifer is unconfined throughout much of the western portion of the model domain (see extent of the UPDCL on Figure 10). Likewise, the Castle Hayne Aquifer is unconfined in the northern portion of the model domain. During model calibration, GMA determined that accurate simulation of water levels in the monitoring wells of these unconfined portions of the aquifers required incorporating the numerous channels and creeks found throughout the area. GMA used drain cells to simulate these groundwater discharge features (Figure 9). In MODFLOW, drain cells represent a type of head dependent flux boundary that only *removes* water from the model. If the head in a drain cell falls below the specified elevation, the flux from the drain model cell drops to zero. Drain elevations were assigned based on available topographic data.

5.3 Model Input

Model input included recharge estimates, hydraulic conductivity values for the aquifers and confining units modeled (Lautier, 1998; GMA, 2018), withdrawals by pumping (Appendix I), and average observed groundwater levels for 2017 (Appendix II). Each of these input parameters is described in the following sections.

Recharge

Recharge via precipitation to the Surficial Aquifer within the Coastal Plain has been estimated to be approximately 15.4 inches per year on average, with only a small portion of that recharge (approximately 0.5 inches) moving down to the confined aquifer system (Leahy and Martin, 1993). In areas where the Surficial Aquifer is in direct contact with the underlying aquifer unit (i.e. the underlying unit is unconfined), recharge is enhanced, and recharge estimates for those conditions range as high 16 inches per year. The recharge values modeled by GMA represent the fraction of total recharge estimated to infiltrate to the deeper aquifers within the model, whether the aquifer is confined or unconfined. The distribution of final calibrated recharge values assigned to the modeled area is shown in Figure 7. Recharge was generally enhanced in areas where the Castle Hayne and Peedee Aquifers are unconfined. GMA also determined during model calibration that increased recharge rates were needed in the vicinity of Boiling Spring Lakes, an area where numerous sinkholes are present (Harden et al., 2003). Sinkholes are areas of land collapse that can result from the dissolution of limestone materials like those of the Castle Hayne Aquifer. Dissolution of limestone may produce cavities in the limestone that become unstable and unable to support the weight of overlying materials. When a sinkhole forms, the collapse breaches the overlying confining layer, thereby causing more direct connection between the surficial aquifer and underlying units. All modeled recharge rates were within the range of published estimates of groundwater recharge (Leahy and Martin, 1993).

Hydraulic Conductivity and Porosity

Hydraulic conductivity (K) is a measure of an aquifer's ability to transmit water. More specifically, hydraulic conductivity is a measure of the volume of water transmitted in a unit of time through a unit area of the aquifer measured at right angles to the direction of flow under a hydraulic gradient of one. Hydraulic conductivity is equal to the transmissivity of an aquifer divided by the aquifer thickness (Heath, 1983). GMA assigned uniform values of hydraulic conductivity to the Castle Hayne Aquifer, the Upper Peedee Aquifer, the Lower Peedee Confining Layer, and the Lower Peedee Aquifer (Table 4). The distributions of hydraulic conductivities applied to the Surficial Aquifer, the Castle Hayne Confining Layer, and the Upper Peedee Confining Layer are shown in Figure 10. Modeled K values were based on measured site-specific data from aquifer testing where available (e.g. GMA, 2018 and the NCDWR online groundwater database [www.ncwater.org]).

Values of vertical hydraulic conductivity (K_v) are generally small and are typically at least an order of magnitude less than the K_h. GMA modeled vertical hydraulic conductivity (K_v) as one order of magnitude less than K_h for all layers (Table 4).

Values of porosity used in the model were primarily derived from NCDWR's model (Lautier, 1998). However, GMA increased porosity values for confining units based upon published values of porosity for fine-grained sediments (Heath, 1983) and based upon GMA's professional experience. Because GMA's MODFLOW model is a steady state model, varying porosity does not affect the steady state equipotential values. Porosity does, however, have an effect on modeled flow velocities. Modeled porosity values are listed in Table 4.

Table 4: Hydraulic Conductivity and Porosity of the Model Layers

Model Layer	Aquifer/Confining Unit	K_h (ft/day)	K_v (ft/day)	Porosity
Layer 1	Surficial Aquifer (SA)	See Figure 10		0.3
Layer 2	Castle Hayne Confining Layer (CHCL)	See Figure 10		0.4
Layer 3	Castle Hayne Aquifer (CHA)	23.4	2.34	0.3
Layer 4	Upper Peedee Confining Layer (UPDCL)	See Figure 10		0.4
Layer 5	Upper Peedee Aquifer (UPDA)	14.8	1.48	0.3
Layer 6	Lower Peedee Confining Layer (LPDCL)	0.0000125	0.00000125	0.4
Layer 7	Lower Peedee Aquifer (LPDA)	14.7	1.47	0.3

Groundwater Withdrawals

The removal of groundwater via pumping wells lowers the hydraulic head in the aquifer, with increasing drawdown occurring closer to the pumping wells. Therefore, groundwater withdrawals must be accounted for during modeling as they may impact groundwater flow patterns. Active pumping wells within the study area during 2017 were identified using NCDWR Ground Water Management Branch Map Interface (www.ncwater.org) (Figure 11). Estimated daily pumping rates were based on average pumping data for 2017, which were available from the NCDWR Ground Water Management Branch Map Interface (NCDWR, 2018; Appendix I).

5.4 Steady-State Calibration

Steady-state flow was simulated to represent conditions in 2017. GMA assigned average head observations from 2017 to 34 monitoring wells within the study area for use during model calibration (Figure 11). Head observations were included for wells screened within the Surficial aquifer (n=11), the Castle Hayne Aquifer (n=4), the Upper Peedee Aquifer (n=14), and the Lower Peedee Aquifer (n=5). GMA adjusted recharge rates, hydraulic conductivities, general head boundaries, and drain elevations and conductivities to achieve a close match of simulated heads with observed head data from 2017. Most adjustments were made manually, meaning parameter values were changed one at a time and the resulting output was compared to known head data. This type of manual trial and error history matching allowed us to improve the model fit while gaining better insight into how the model behaves. Final calibration of hydraulic conductivities and recharge rates was accomplished using PEST, a model-independent parameter estimation and uncertainty analysis, to achieve an optimal match between known and simulated head values. All final recharge and hydraulic conductivity values were within the range of published values for the model domain.

A comparison between modeled and observed groundwater levels indicate a good fit ($r^2 = 0.98$, Figure 12). We achieved a mean absolute residual error of 1.61 feet and a root mean squared residual of 2.07 feet. Calibrated head data were used to prepare potentiometric surface maps for all four modeled aquifers to simulate groundwater head elevations and flow directions within these units prior to any further channel deepening (Figures 13 - 16).

5.6 Predicted Groundwater Flow Patterns

Results from the baseline calibrated model of existing conditions indicate that, consistent with the findings of the NCDWR study, the Cape Fear River serves primarily as a discharge area for the Surficial Aquifer (Figure 13). Heads in the Surficial Aquifer adjacent to the river channel are higher than the average water level in the River, and groundwater flow is toward the River. The Cape Fear River also acts as a discharge area for both the Castle Hayne and the Upper Peedee Aquifers, except in local areas where pumping from wells has depressurized those units. The Upper Peedee Aquifer is unconfined throughout much of the western portion of the model domain, and groundwater flow patterns within this unit mimic the patterns seen in the Surficial Aquifer. In contrast, the Lower Peedee Aquifer is well-confined, and, based upon model results, it appears to be uninfluenced by the Cape Fear River channel. Figure 16 illustrates that the modeled equipotential surface of the Lower Peedee Aquifer is not affected by the Cape Fear River.

5.6.1 Areas of Aquifer Depressurization Due to Pumping

Model simulations reveal five general areas where pumping has lowered groundwater heads beneath sea level. Aquifer depressurization below sea level creates the *potential* for salty surface water to migrate downward into the groundwater system (Figure 17). Those identified areas with a downward-directed head potential are:

1) in Southport in the vicinity of the Capital Power Corporation withdrawal
2) around the Carolina Beach and Kure Beach water-supply well fields
3) in the vicinity of the industrial supply wells owned by Invista Sarl
4) around the Wrightsville Beach well field
5) around the Bald Head Island well field

These five depressurized areas are discussed below with a consideration of their positions relative to the proposed channel modifications.

Area 1 – The Capital Power Corporation withdrawal at Southport

The Capital Power Corporation withdraws groundwater from the Upper Peedee Aquifer in the Southport area. Model results indicate that the cone of depression in the Upper Peedee Aquifer from this withdrawal extends beneath the Cape Fear River (Figure 15).

The newly constructed monitoring well station at Southport includes Surficial, Castle Hayne, and Upper Peedee Aquifer monitoring wells placed adjacent to the Cape Fear River, between the river channel and the Capital Power Corporation wellfield (GMA, 2018). Groundwater heads in the Upper Peedee monitoring well are consistently approximately 4 feet below mean sea level as a result of pumping from the Capital Power Corporation wellfield. Despite the downward directed head gradient relative to the River, groundwater samples collected from this well are fresh, which indicates that the Upper Peedee Aquifer is well confined in this region. Furthermore, tidal variation of water levels in the Upper Peedee Aquifer monitoring well is muted, indicating that the aquifer is not directly connected to tidal surface water in the Cape Fear River. Because the Upper Peedee Aquifer is well confined in this region, any downward migration of surface water would be minimized.

The model results indicate a downward-directed head potential in layer 2 beneath the River in the Southport area, but predicted head values were less than 0.1 feet below sea level. Any water from the river would have to pass through the Castle Hayne Aquifer on its path downward toward the Upper Peedee. Hydraulic head in the Castle Hayne monitoring well at

Site #3 was measured to be above mean sea level (GMA, 2018), which demonstrates that the Castle Hayne Aquifer discharges into the Cape Fear River in this area. The higher head in the Castle Hayne Aquifer in this area may serve as a hydraulic barrier to downward movement of salty surface water into the Peedee. The presence of freshwater in the Surficial, Castle Hayne, and the Upper Peedee Aquifers at Site #3 helps confirm that groundwater is discharging to the Cape Fear River at this location, suggesting that saltwater intrusion is not occurring as a result of the Capital Power Corporation wellfield.

Area 2 – The Carolina Beach and Kure Beach Wellfields

The Carolina Beach wellfield exists in close proximity to a paleochannel where erosion has removed the Castle Hayne Confining Layer, thereby exposing the Castle Hayne Aquifer to enhanced local recharge from the Surficial Aquifer. The paleochannel was backfilled by high-permeability sandy sediments of the Surficial Aquifer. This paleochannel was described by the US Geological Survey (Bain, 1970), and the feature was incorporated into the NCDWR model (Lautier, 1998) and into the current MODFLOW model. The lack of effective confinement of the Castle Hayne Aquifer near Carolina Beach makes the area vulnerable to saltwater intrusion from the ocean and from the Cape Fear River. Furthermore, this region also exhibits thinning or absence of the confining layer between the Castle Hayne and the Upper Peedee Aquifers. Groundwater withdrawals from the Upper Peedee and Castle Hayne Aquifers at Carolina Beach and at Kure Beach have locally lowered the potentiometric surfaces within these aquifers to below sea level, thereby allowing water from the Surficial Aquifer, and from adjacent surface water bodies (the Ocean and the Cape Fear River), to move downward into the Castle Hayne and Peedee Aquifers.

Existing localized saltwater intrusion in the vicinity of Carolina Beach has been an ongoing challenge to the Carolina Beach public water system (GMA, 2007). Our groundwater flow model results predict groundwater levels below sea level in the vicinity of Carolina Beach. This prediction is consistent with existing known saltwater intrusion issues. It is important to note that the NCDWR model (Lautier, 1998) also identified a local area of depressurization below sea level in the Peedee Aquifer near Carolina Beach. Expanded groundwater withdrawals from this area since 1998 have resulted in a larger cone of depression, which is depicted in GMA's groundwater model, and this cone of depression extends to the Cape Fear River shoreline.

The area of saltwater intrusion potential near Carolina Beach is intrinsic to the existing geological conditions (i.e., poor confinement of the Castle Hayne and Upper Peedee Aquifers) and to the groundwater withdrawal patterns that have lowered the equipotential surface below sea level. The existing localized saltwater intrusion issues at Carolina Beach appear to be unrelated to the existing navigation channel of the Cape Fear River, because the depressurization below sea level does not extend beneath the river to the dredged navigation channel position. The navigation channel is on the west side of the Cape Fear River (Figure 1), more than a mile away from the Carolina Beach and Kure Beach well fields. Instead, brackish water near the shoreline of the Cape Fear River drains from the river down into the groundwater system and migrates toward the pumping wells. This pattern of saltwater intrusion from the Cape Fear River would occur whether or not the dredged navigation channel existed.

Area 3 – The Invista SARL Industrial Supply Wells

The peninsula between the Cape Fear and Northeast Cape Fear Rivers at Wilmington includes extensive industrial development. Multiple water-supply wells, including industrial and potable wells, are operated on the peninsula. The majority of the wells are shallow and have low yields. However, the Invista SARL plant operated a wellfield in 2017 for industrial water supply that averaged approximately 1 million gallons per day of groundwater withdrawal, and this well field was by far the largest groundwater withdrawal on the peninsula. The combined withdrawals of Invista and other pumping wells on the peninsula have depressurized the Upper Peedee, Castle Hayne, and Surficial Aquifers to elevations below sea level (Figures 13-15). This cone of depression is modeled as extending across the peninsula, and it encounters the channels of the Cape Fear River (on the west side) and Northeast Cape Fear River (to the east). GMA is unaware of any reported saltwater intrusion associated with this cone of depression. However, the NC Division of Water Resources does not maintain a monitoring well station on the peninsula, so the area lacks public information on water levels and salinity within the cone of depression. Despite the presence of a cone of depression and the associated potential for saltwater intrusion, the modeled area of drawdown below sea level is more than 3 miles north of the Cape Fear River Navigation Channel. As such, the area of drawdown would be unaffected by the proposed navigation channel improvements.

Area 4 – The Wrightsville Beach Well Field

The Town of Wrightsville Beach operates a public water supply system that includes 10 wells pumping from the Upper Peedee Aquifer. The withdrawals from the well field have induced a cone of depression within the Upper Peedee Aquifer that has locally lowered groundwater head to below sea level. The Town has experienced local saltwater intrusion into the wellfield due to the proximity to the Atlantic Ocean and the Intracoastal Waterway. The Wrightsville Beach cone of depression is more than 7 miles east of the Cape Fear River Navigation Channel. Furthermore, our MODFLOW model demonstrates a hydraulic divide in the Upper Peedee Aquifer between the Cape Fear River and the Wrightsville Beach well field (Figure 15). Proposed channel modifications could have no effect on the potential for saltwater intrusion into the Wrightsville Beach wells.

Area 5 – Bald Head Island

Bald Head Island obtains potable water from a combination of shallow wells, withdrawing from the Surficial Aquifer, and purchased water that is transferred from Brunswick County via a pipeline under the Cape Fear River. The Bald Head Island well field includes 16 wells that are all less than 65 feet depth. The combined capacity of the well field is 0.36 MGD, and individual wells produce about 30 gallons per minute. Local areas within the wellfield induce drawdown to elevations below sea level. However, the drawdown areas do not extend beneath the Cape Fear River Navigation Channel.

5.6.2 Simulation of Channel Modifications and Projected Sea Level Rise

Moffatt and Nichol provided GMA with detailed bathymetric data for both the existing and the proposed 47-foot channel deepening configuration. GMA used these data to modify the elevation of the top of the model grid to match the planned channel depths. In areas where the thickness of layer one beneath the channel was 5 feet or less, GMA evaluated whether the deepening would breach the existing hydrostratigraphic layer and expose new material along the channel bottom. If the existing layer was breached, GMA changed the properties of those cells to match the appropriate underlying material. GMA then re-ran the calibrated model to simulate the effects of channel deepening on groundwater flow within the system.

Model results indicate that the proposed channel deepening project will not significantly influence groundwater flow patterns. In fact, groundwater flow patterns for all four modeled aquifers (SA, CHA, UPDA, and the LPDA) for the proposed channel modification simulation (Figures 18-21) were virtually identical to groundwater flow patterns prior to channel modification (Figures 13-16).

Because the proposed channel deepening adjacent to the Capital Power Corporation wells does not breach the Upper Peedee Confining Layer, the proposed channel does not increase the potential for saltwater intrusion into the Upper Peedee Aquifer in that area (Figures 30 and 31). Model simulations reveal no effect on the groundwater flow patterns near Southport in response to proposed channel modifications (Figures 18 – 21).

Simulations also indicate that the planned channel improvement will not increase the potential for saltwater migration in the vicinity of the Carolina Beach or Kure Beach municipal water supply wells (Figure 30). The predicted depressurized area around these well fields impinges upon the shoreline of the Cape Fear River, but does not extend to the navigational channel on the west side of the river. If these wells are pumped excessively, especially those closest to the river, salinity may increase as salty surface water migrates towards the wellfield. Model results suggest, however, that the channel deepening is too far removed from the pumping wells at Carolina Beach and Kure Beach to affect saltwater intrusion in this semiconfined area.

To evaluate the potential effects of sea-level rise, GMA also ran simulations on both the existing and the modified channel geometry under a projected 2.56 foot rise in sea level. This corresponds to the Army Corps of Engineers' "high" estimate for projected sea-level rise for the year 2077 (50 years after construction is completed). GMA's groundwater simulations of this projected sea-level rise indicate that sea-level rise, both with and without channel modifications, will result in very little changes to the patterns of groundwater flow and discharge within the model area (Figures 22-29). Model results suggest that sea-level rise will not discernably increase the potential for saltwater intrusion associated with proposed channel modifications. These conclusions are based upon the assumption that no new groundwater withdrawals occur in close proximity to the Cape Fear River from now until year 2077.

5.7 Sensitivity Analysis

As part of the steady-state model calibration process, GMA performed a sensitivity analysis to evaluate the relation between model input parameter variability and the calculated hydraulic head. The most sensitive parameters are the most important parameters for causing the model to match the observed values. Insensitive parameters have less effect on reaching model calibration targets.

Model response was tested for sensitivity to recharge and hydraulic conductivity values using the PEST (Parameter ESTimation) utility. PEST analysis indicated that the model was most sensitive to the amount of recharge applied to zones 4, 5, and 6 (Figure 32). The model was also sensitive to hydraulic conductivity values in the Upper Peedee Aquifer, the Surficial Aquifer, and the Castle Hayne Confining Layer. During the manual trial and error calibration process, GMA also noted that the model was sensitive to drain elevations in the western portion of the model. This corresponds to the area where the Upper Peedee Aquifer is unconfined and is consistent with the areas of sensitive model parameters described above.

5.8 Model Limitations

The steady-state, finite-difference model described in this report appropriately simulates regional groundwater flow patterns in the vicinity of the Cape Fear River Navigation Channel. However, due to the inherent complexities of groundwater flow systems in both space and time, and considering limitations on available data and computing capabilities, there are some model limitations.

Any model is limited by the quantity and quality of the supporting data. This model has the benefit of representing an area that is well studied and has been previously modeled by the NCDWR. As with any model, however, there is a fair degree of uncertainty in the hydraulic properties of the aquifers and confining units. Site-specific parameters were used whenever available. At locations without known data, GMA used hydraulic property values obtained from the literature or those based on GMA's experience with the hydrogeology of this region.

This model, like all models, is also limited by grid spacing. Although the grid spacing of this model adequately allows for simulation of the hydrologic system within the area, data input and simulation results are averaged over the entire cell (approximately 23 acres per cell). Consequently, small heterogeneities within the system, such as steep elevation changes or clusters of pumping wells, can result in discrepancies between modeled and observed values. Also, because the steady-state model is calibrated to average groundwater levels and pumping rates for 2017, the model does not account for potential seasonal variation in groundwater recharge or withdrawals rates.

GMA contends that this model reasonably simulates current groundwater flow patterns and flow patterns that result from the proposed channel deepening. The model also reasonably simulates the influence of projected future sea-level rise on groundwater flow conditions.

6.0 CONCLUSIONS

GMA has completed a predictive modeling analysis of groundwater flow in and around the Cape Fear River Navigation Channel under current channel configuration and after channel deepening to 47 feet. GMA also completed predictive modeling for both channel configurations under the Army Corps of Engineers' highest estimated sea-level rise (2.56 feet) for the year 2077. GMA's groundwater model focused on determining the potential impacts on saltwater intrusion resulting from the proposed channel deepening project.

Based upon our modeling efforts, GMA concludes the following:

- Groundwater modeling indicates that the proposed channel modifications will not increase the potential for saltwater intrusion above what currently exists within the system.
- Modeling indicates that the cone of depression from pumping in the Southport area extends beneath the Cape Fear River, and this pumping has created the *potential* for downward migration of salty surface water into the Upper Peedee Aquifer. Importantly, however, the Upper Peedee Aquifer in this area is well confined, and the aquifer exists approximately 50 feet *below* the proposed channel bottom. Thus, the proposed channel deepening near Southport would not impact the degree of confinement of the Upper Peedee Aquifer beneath the channel.
- The proposed channel modifications near Carolina Beach are not projected to affect the potential for saltwater intrusion in that area. The naturally poor confinement of the Castle Hayne and Peedee Aquifers near Carolina Beach, and the existing groundwater withdrawal conditions have resulted in localized saltwater intrusion under existing conditions. Model results indicate that the proposed channel modifications do not alter these existing groundwater conditions.
- Bald Head Island obtains a portion of its potable water supply from a combination of shallow wells (<65 feet depth that withdraw from the Surficial Aquifer). Local areas within the wellfield induce drawdown to elevations below sea level. However, the drawdown areas do not extend beneath the Cape Fear River Navigation Channel, and model results indicate that channel deepening will have no effect on the water supply to these wells.

- The potential for future saltwater intrusion into fresh aquifers adjacent to the Cape Fear River is dominantly determined by local groundwater use in proximity to the river. As long as the groundwater resources are managed appropriately to avoid depressurization below sea level, the Cape Fear River should remain a discharge area and further modification of the channel should not increase saltwater intrusion in these vital coastal aquifers. This need for continued sustainability-based groundwater management is paramount, but independent from the planned navigation channel improvements for the Port of Wilmington.

7.0 REPORT CERTIFICATION

This report was prepared by Groundwater Management Associates, Inc., a professional corporation licensed to practice geology (NC Corporate License No. C-121) and engineering (NC Corporate License No. C-0854) in North Carolina. We, Emma H. Shipley, James K. Holley, and Richard K. Spruill, North Carolina Licensed Geologists for GMA, do certify that the information contained in this report is correct and accurate to the best of our knowledge.

SEAL 2369 2-15-19
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Emma Shipley, P.G.
Project Hydrogeologist

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James K. Holley, P.G.
Senior Hydrogeologist

Richard K. Spruill
Richard K. Spruill, Ph.D., P.G.
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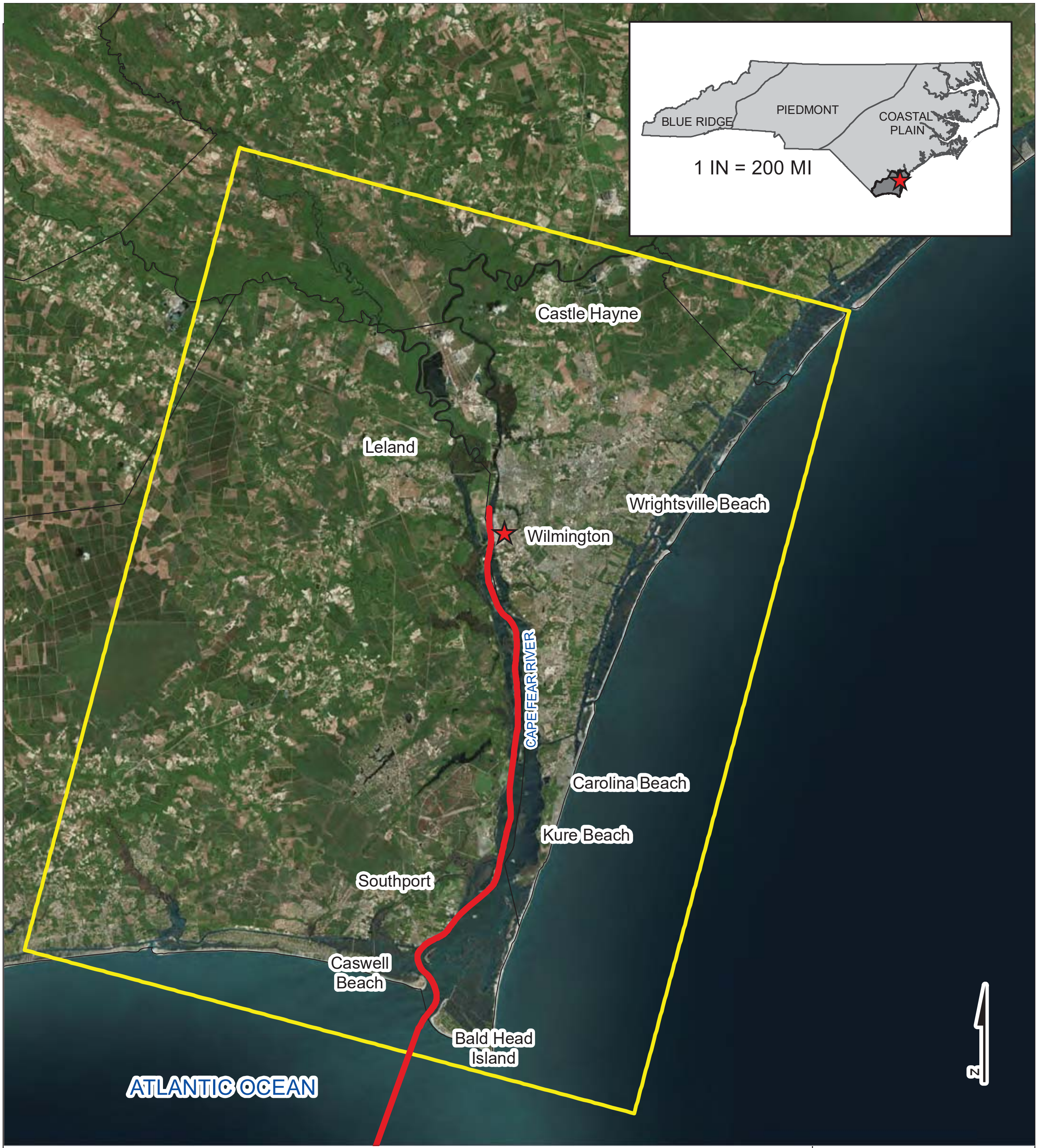
FIGURES



LEGEND

★ WILMINGTON PORT

— NAVIGATION CHANNEL

☐ MODEL EXTENT

0 35,000

Feet

1 " = 35,000 '

GMA

File: DRAWINGS/16001/
DREDGE_CHANNEL_LOCATION_INSET

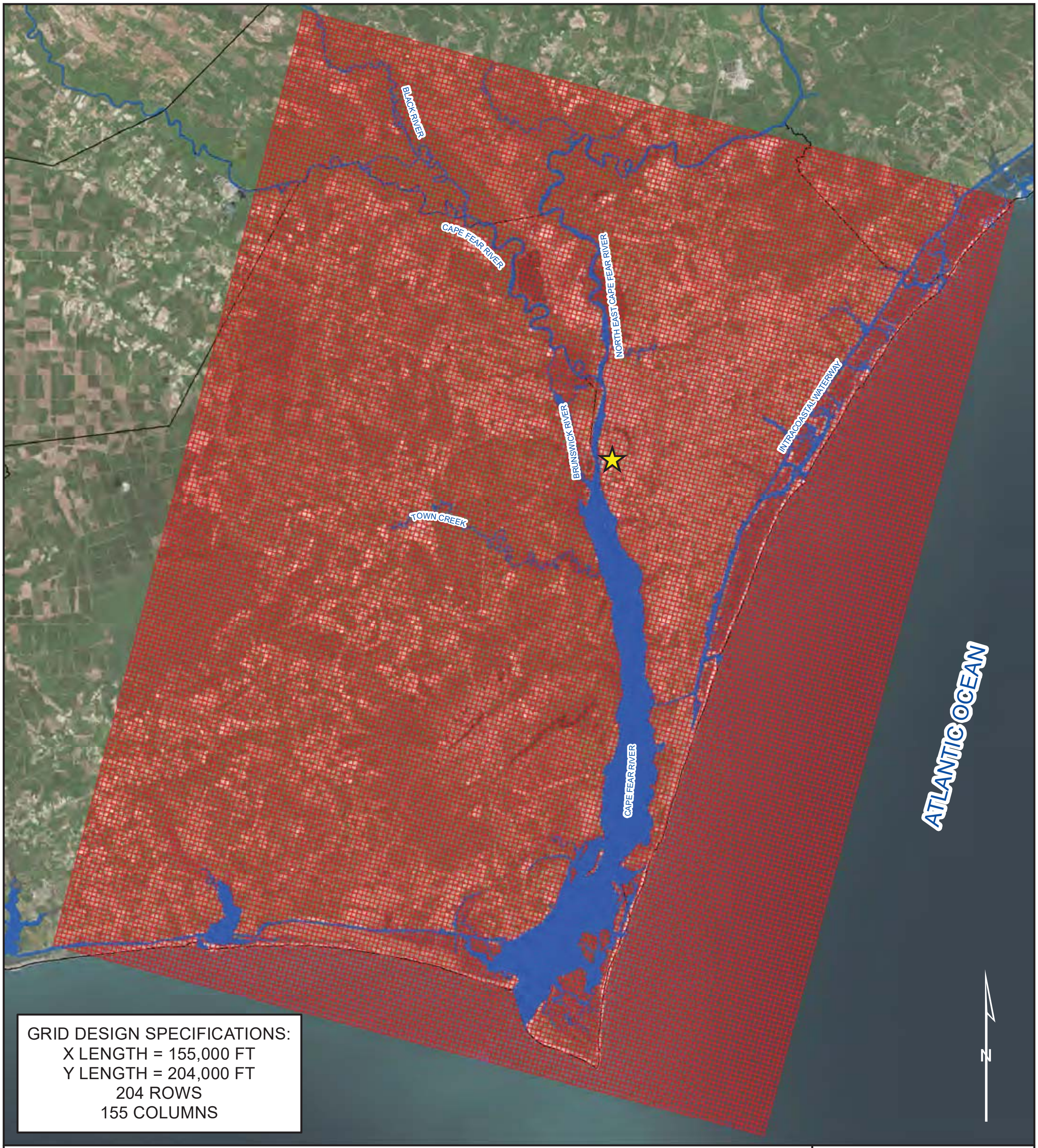
PORT OF WILMINGTON NAVIGATION CHANNEL

DATE: 11/01/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 1



GRID DESIGN SPECIFICATIONS:
X LENGTH = 155,000 FT
Y LENGTH = 204,000 FT
204 ROWS
155 COLUMNS

LEGEND

★ WILMINGTON PORT
🟦 WATER FEATURES
☐ MODEL GRID

0 30,000
Feet
1 " = 30,000 '

File: DRAWINGS/16001/
MODEL_GRID_DESIGN

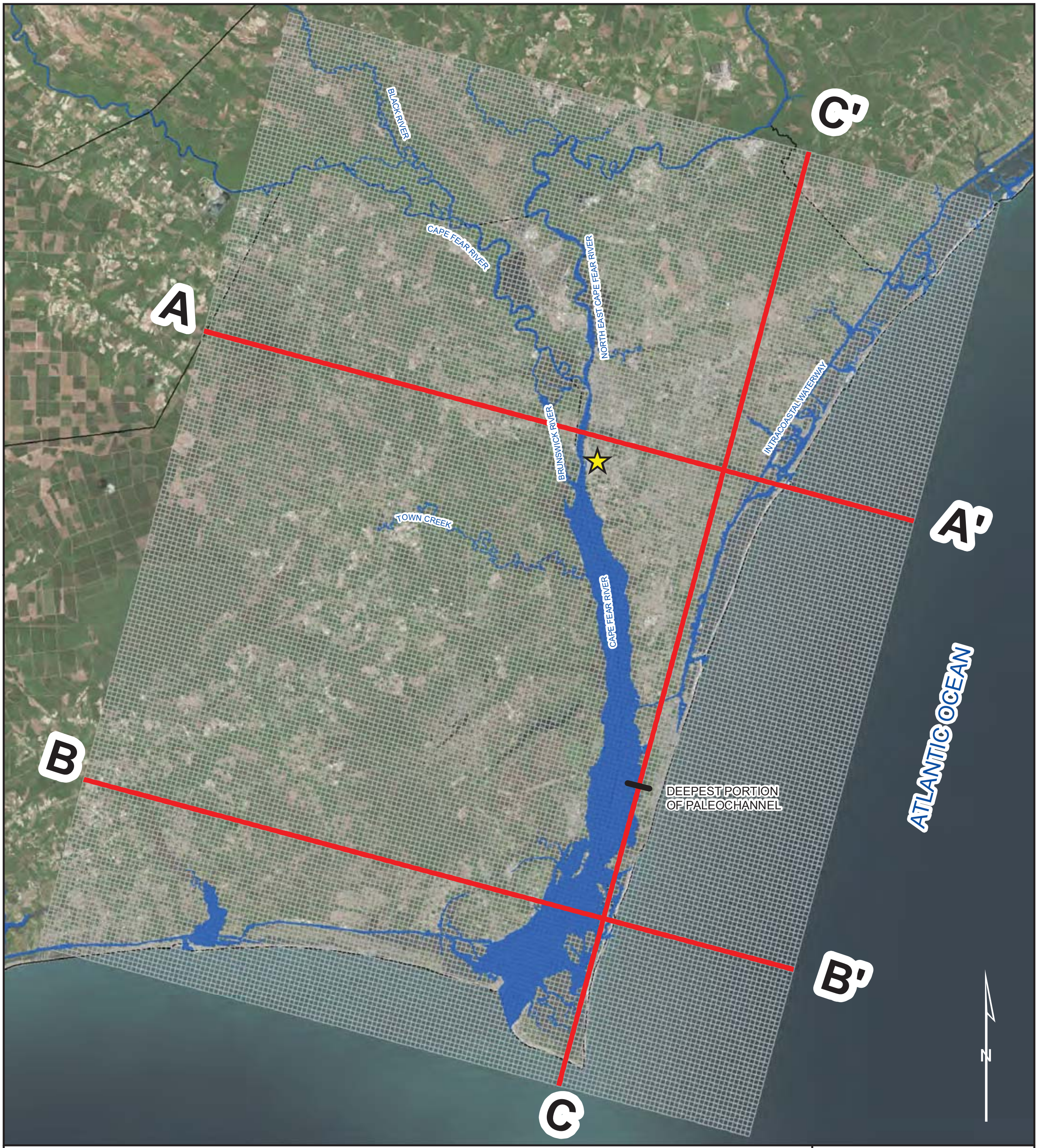
MODEL GRID DESIGN

DATE: 11/20/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 2



LEGEND

★ WILMINGTON PORT

🟦 WATER FEATURES

☐ MODEL GRID

0 30,000 Feet

1 " = 30,000 '

GMA

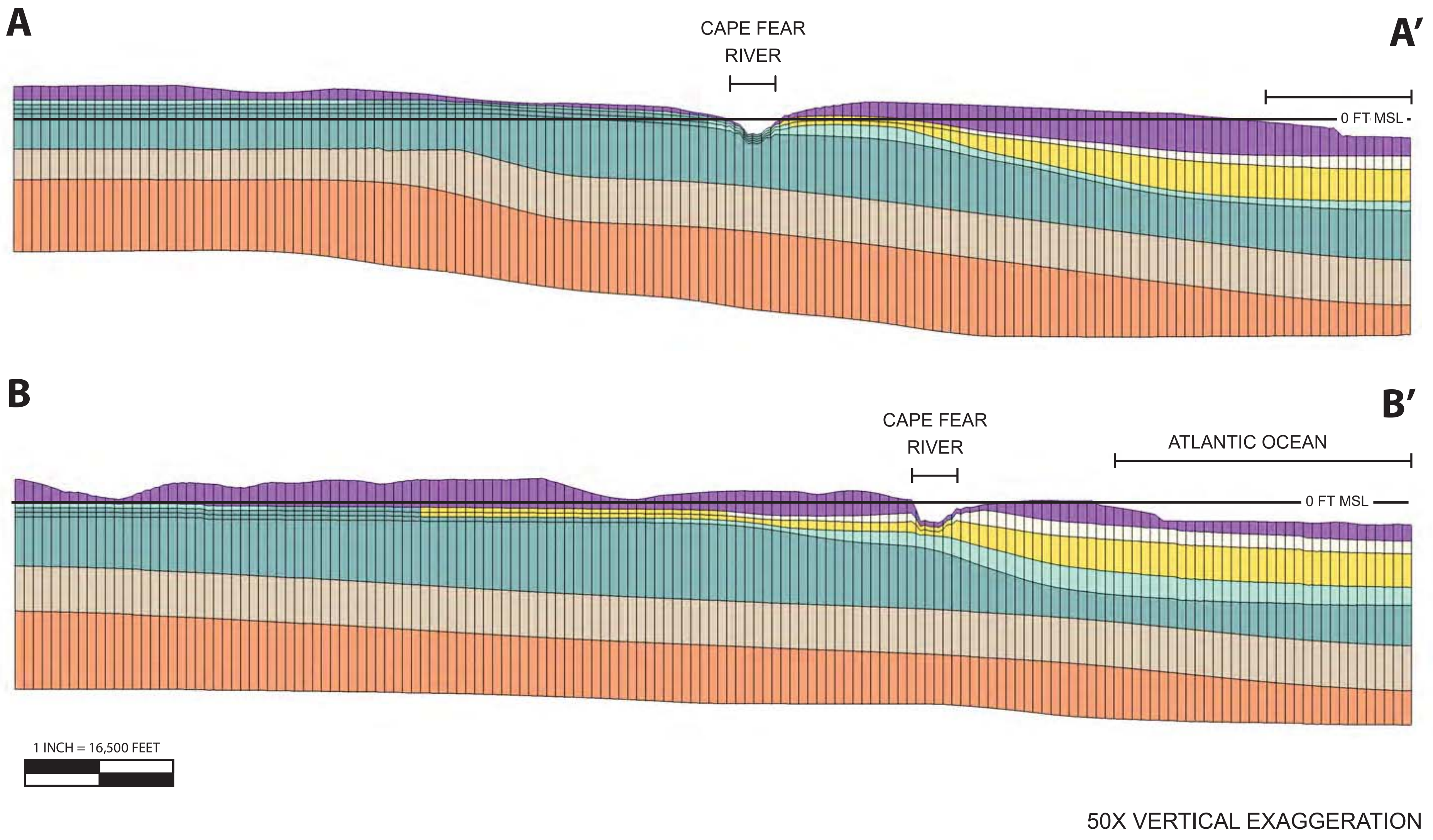
CROSS-SECTION LOCATIONS

DATE: 11/27/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

FIGURE 3



-LEGEND-

🟪 SURFICIAL AQUIFER
⬜ CASTLE HAYNE CONFINING LAYER
🟨 CASTLE HAYNE AQUIFER
🟩 UPPER PEEDEE CONFINING LAYER
🟦 UPPER PEEDEE AQUIFER
🟫 LOWER PEEDEE CONFINING LAYER
🟧 LOWER PEEDEE AQUIFER

GMA
GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/
MODEL XSEC W-E.PDF

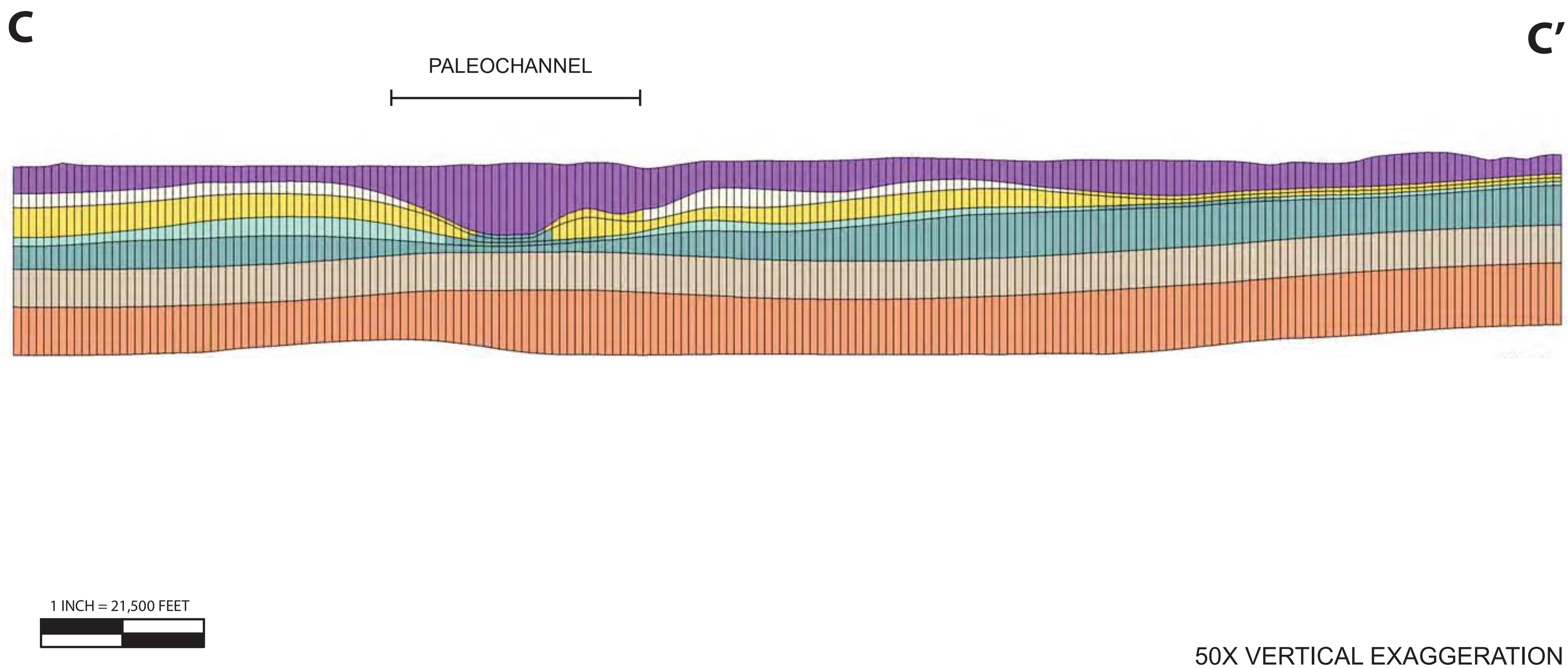
WEST TO EAST CROSS-SECTIONS SHOWING VERTICAL DISTRIBUTION OF MODEL LAYERS

DATE: 11/27/2018

PROJECT 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 4



50X VERTICAL EXAGGERATION

-LEGEND-

- SURFICIAL AQUIFER
- CASTLE HAYNE CONFINING LAYER
- CASTLE HAYNE AQUIFER
- UPPER PEEDEE CONFINING LAYER
- UPPER PEEDEE AQUIFER
- LOWER PEEDEE CONFINING LAYER
- LOWER PEEDEE AQUIFER

GROUNDWATER MANAGEMENT ASSOCIATES, INC.

File: DRAWINGS/160001/
MODEL XSEC S-N.PDF

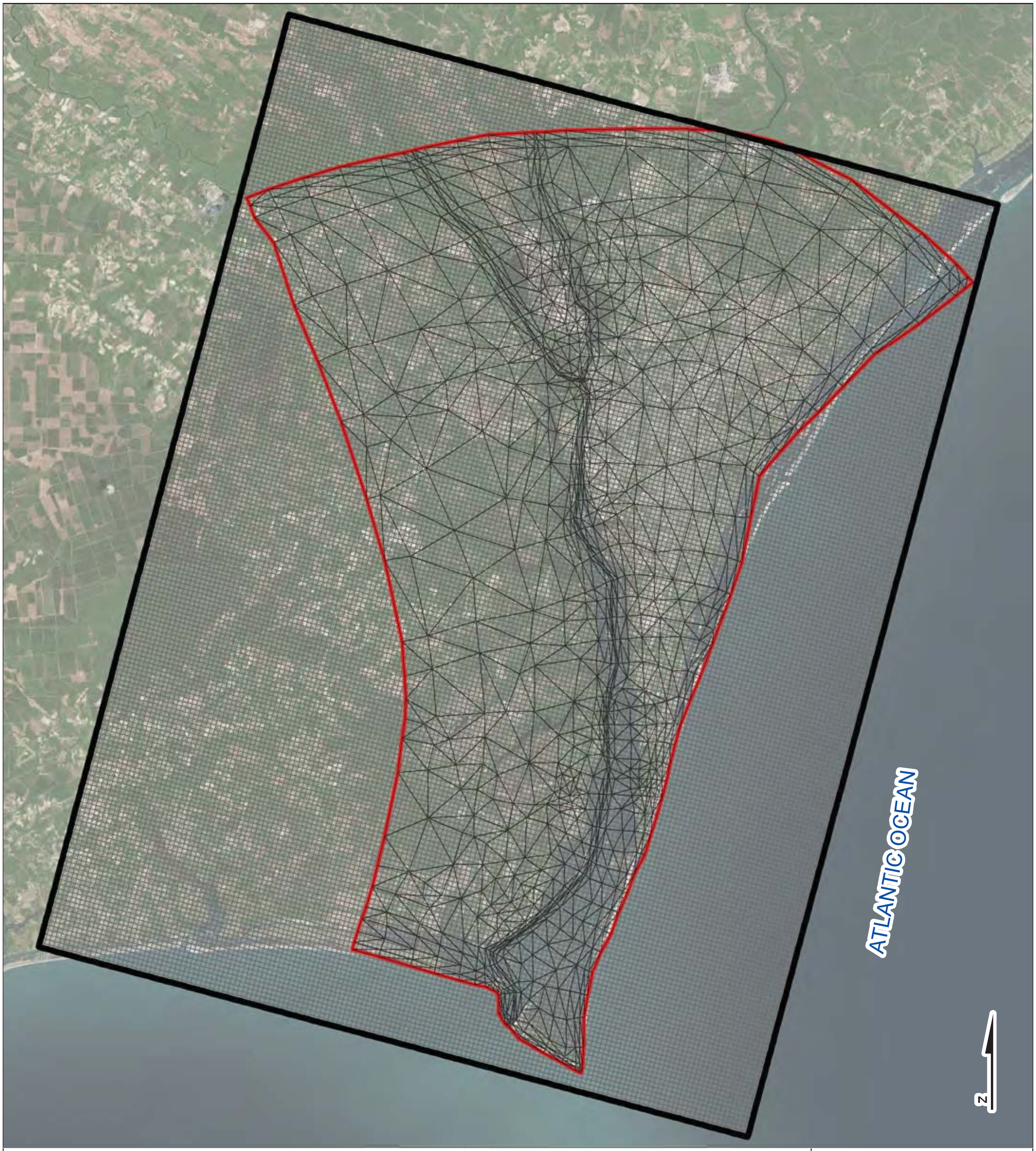
SOUTH TO NORTH CROSS-SECTION SHOWING VERTICAL DISTRIBUTION OF MODEL LAYERS

DATE: 11/27/2018

PROJECT 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 5



LEGEND

GMA MODFLOW MODEL GRID

NCDWR FEMWATER MODEL GRID

0 30,000 Feet

1 " = 30,000 '

GMA

File: DRAWINGS/16001/
LAUTIER_vs_GMA_EXTENT.mxd

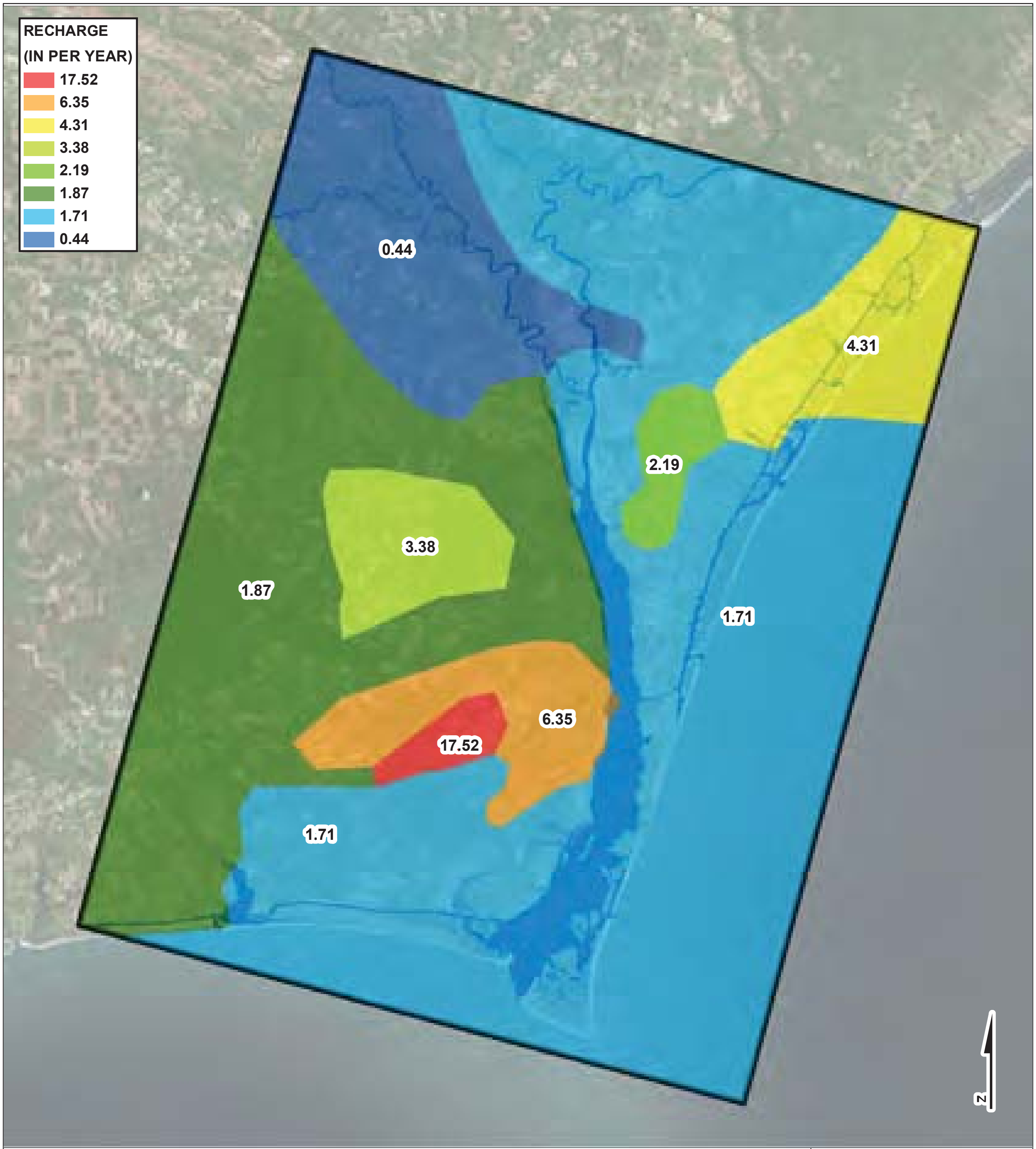
COMPARISON BETWEEN 1998 NCDWR FEMWATER MODEL EXTENT AND GMA MODFLOW MODEL EXTENT

DATE: 12/4/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

FIGURE 6



LEGEND

▭ MODEL DOMAIN

0 32,000
Feet
1 " = 32,000 '

GMA

File: Drawings\160001\ MODEL_REPORT_FIGS\RECHARGE.mxd	RECHARGE ZONES	DATE: 11/15/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 7

SURFICIAL AQUIFER

LOWER PEEDEE AQUIFER

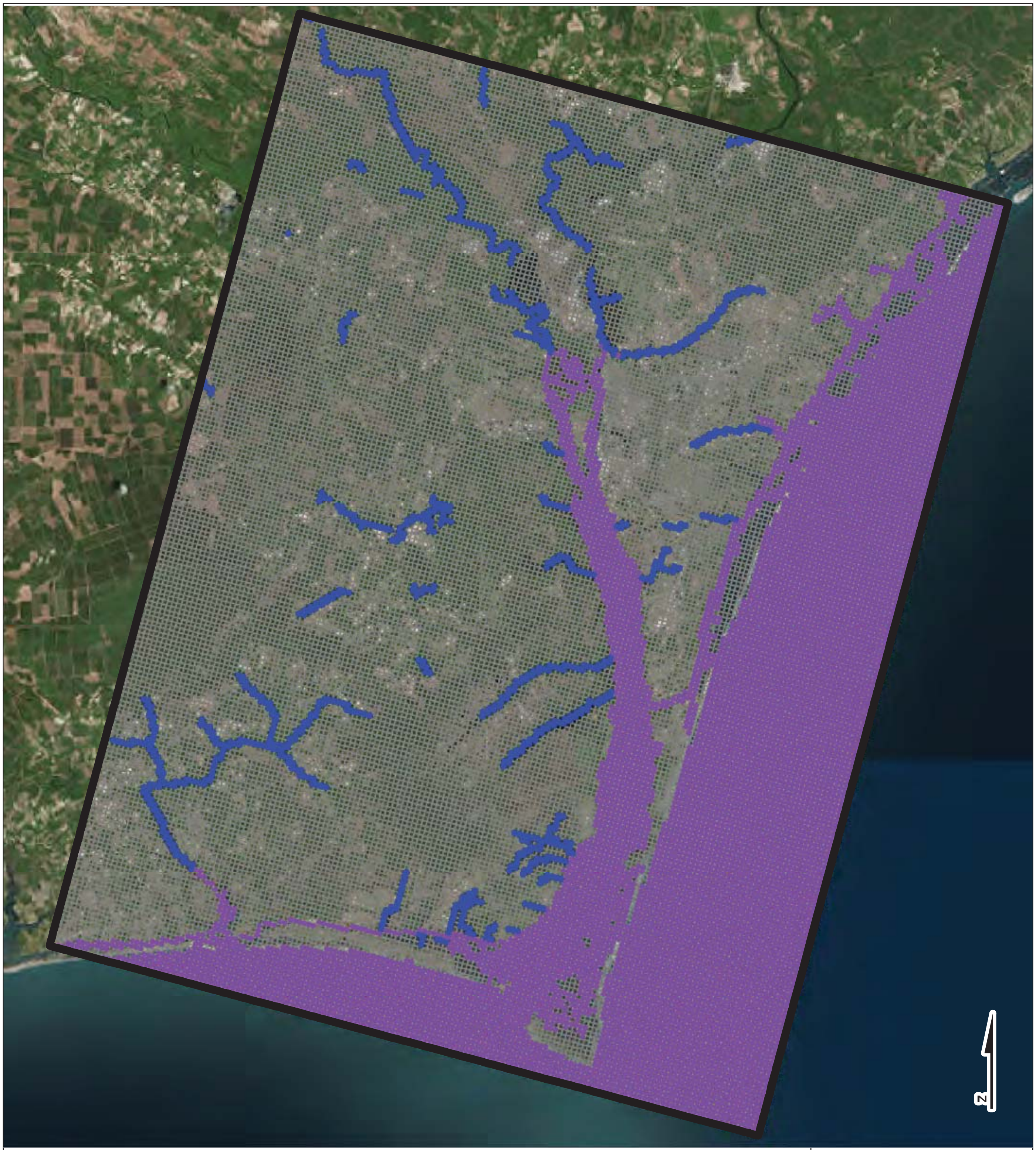
LEGEND

🟥 GENERAL HEAD CELL

🟦 MODEL BOUNDARY

GMA

Z:\Drawings\160001\FIG 7 FIG 7 GHBs.pdf	LOCATIONS OF GENERAL HEAD BOUNDARIES	DATE: 11/28/2018
PROJECT: 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 8



LEGEND

▭ MODEL DOMAIN

🟪 CONSTANT HEAD CELL

🟦 DRAIN CELL

1 " = 30,000 '

File: Drawings\160001\
DRAINS.mxd

LOCATIONS OF DRAINS AND CONSTANT HEAD BOUNDARIES

DATE: 11/28/2018

PROJECT NO. 160001

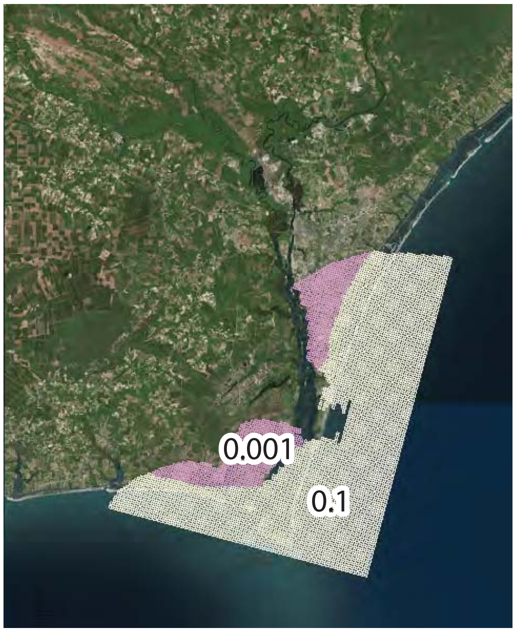
PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 9

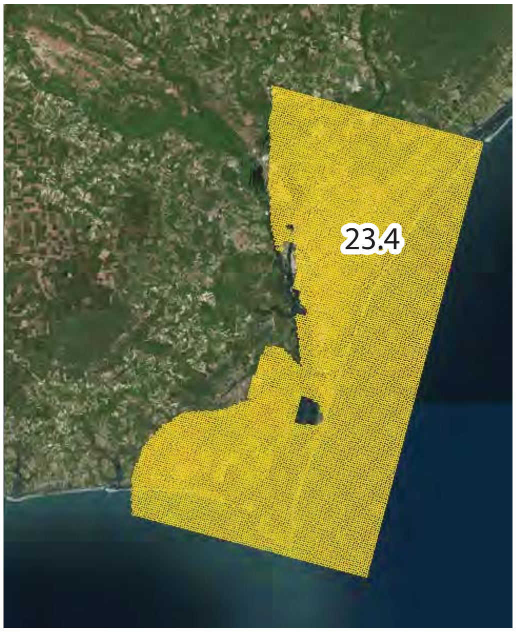
HORIZONTAL HYDRAULIC CONDUCTIVITY (K_h; FEET/DAY)

SURFICIAL AQUIFER

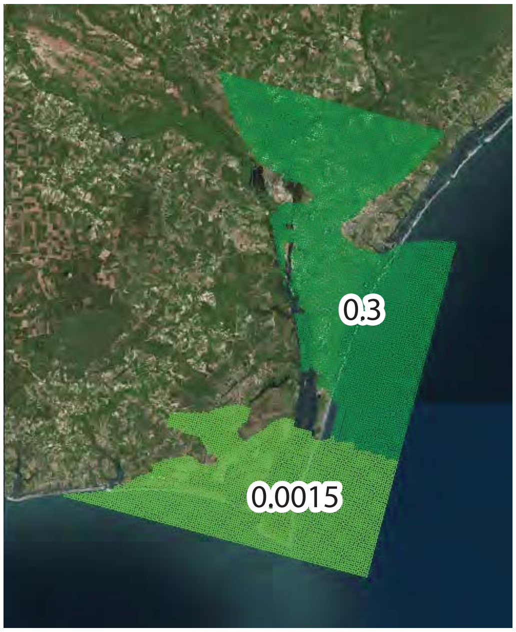
CASTLE HAYNE CONFINING LAYER



CASTLE HAYNE AQUIFER



UPPER PEEDEE CONFINING LAYER



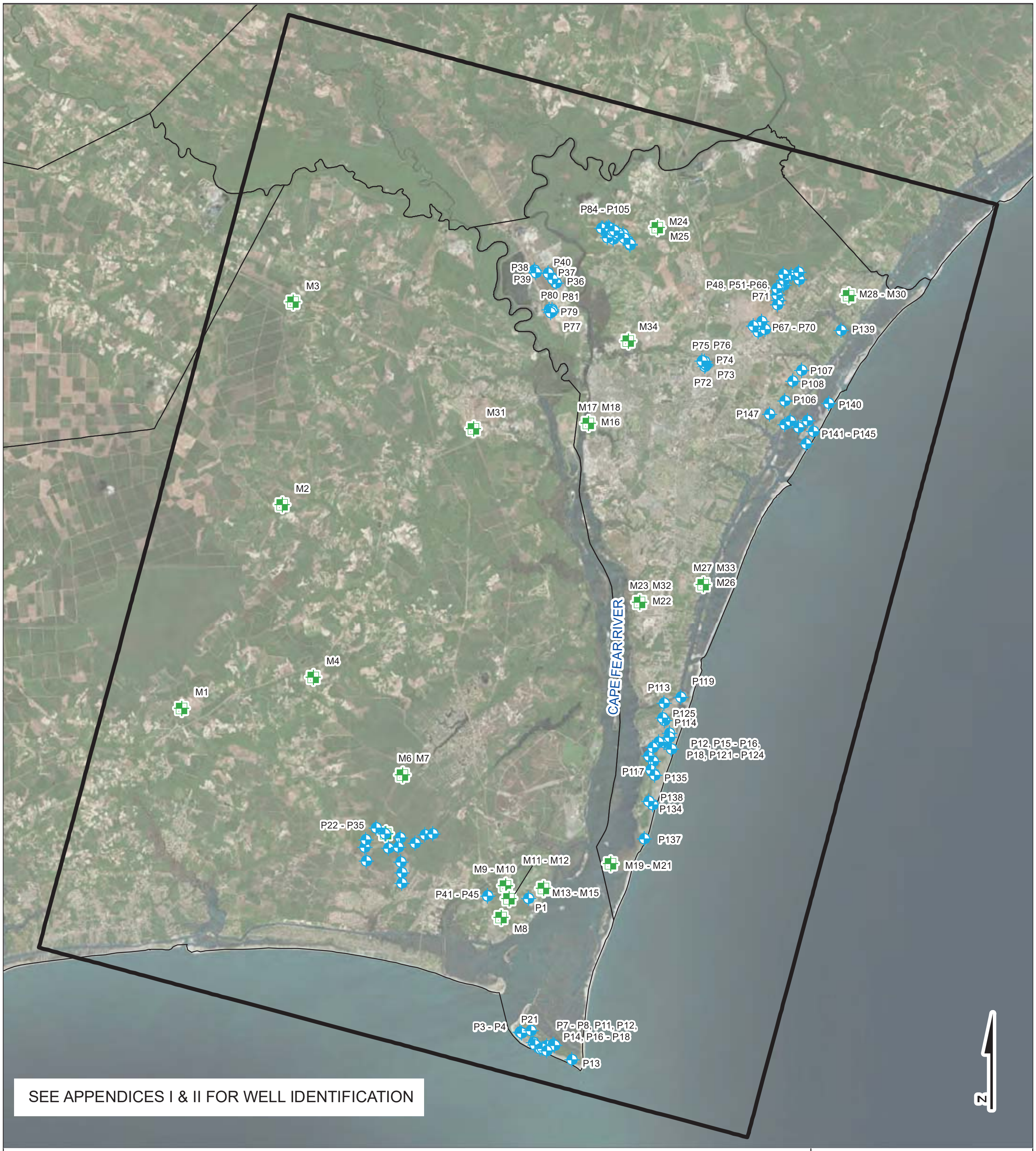
UPPER PEEDEE AQUIFER: K_h= 14.8 FEET/DAY

LOWER PEEDEE CONFINING LAYER: K_h= 0.0000125 FEET/DAY

LOWER PEEDEE AQUIFER: K_h= 14.7 FEET/DAY

GMA

Z:\Drawings\160001\	MODELED HORIZONTAL HYDRAULIC CONDUCTIVITY DISTRIBUTIONS	DATE: 12/4/2018
PROJECT: 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 10



SEE APPENDICES I & II FOR WELL IDENTIFICATION

LEGEND

▭ MODEL EXTENT	✚ MONITORING WELL
▭ COUNTY BOUNDARIES	⊕ WATER-SUPPLY WELL

0 30,000 Feet

1 " = 30,000 '

GMA

File: DRAWINGS/16001/
WELL_LOCATIONS_SOURCES

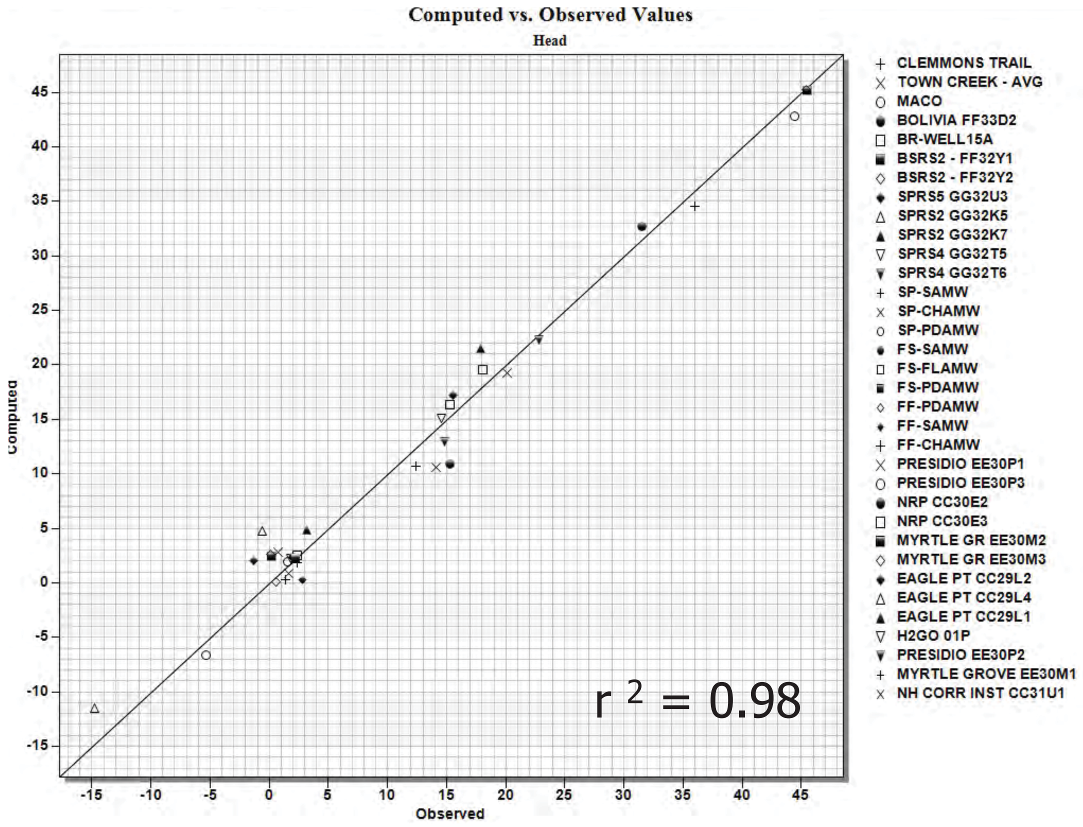
OBSERVATION AND GROUNDWATER WITHDRAWAL
WELLS USED IN THE MODEL

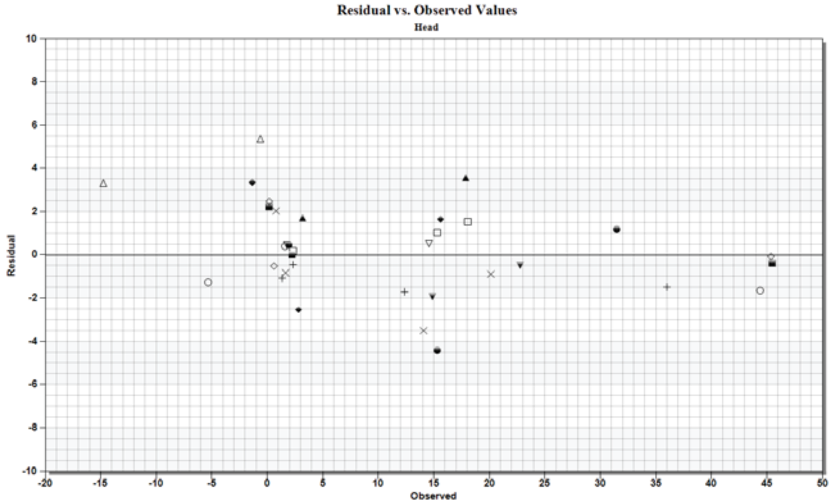
DATE: 11/29/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 11

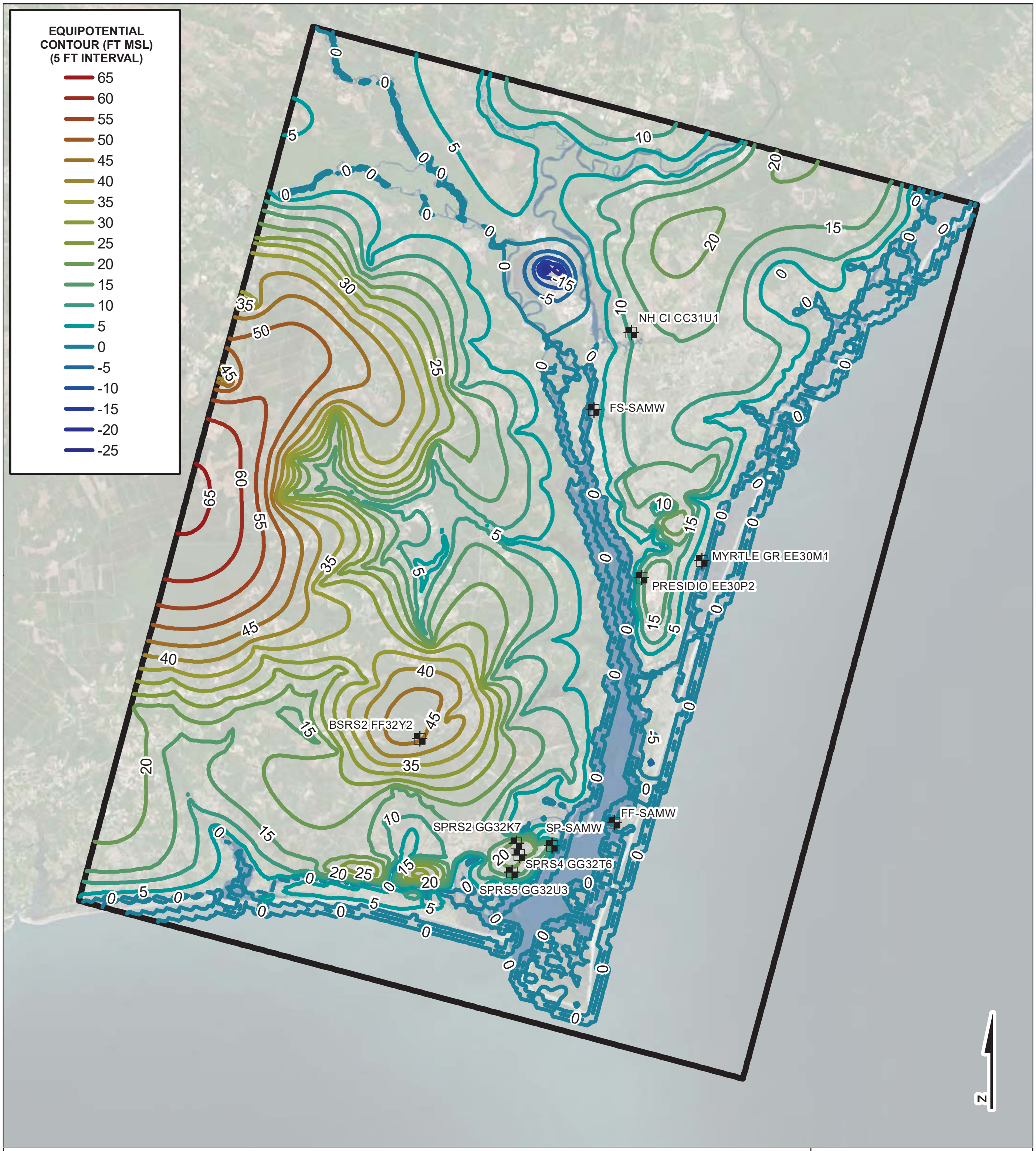




STATISTICS

Mean Residual (Head, in feet)	-0.24
Mean Absolute Residual (Head, in feet)	1.61
Root Mean Squared Residual (Head, in feet)	2.07

Z:\Drawings\160001\FIG 2.PDF	MODEL CALIBRATION PLOTS	DATE: 11/20/2018
PROJECT: 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 12



LEGEND

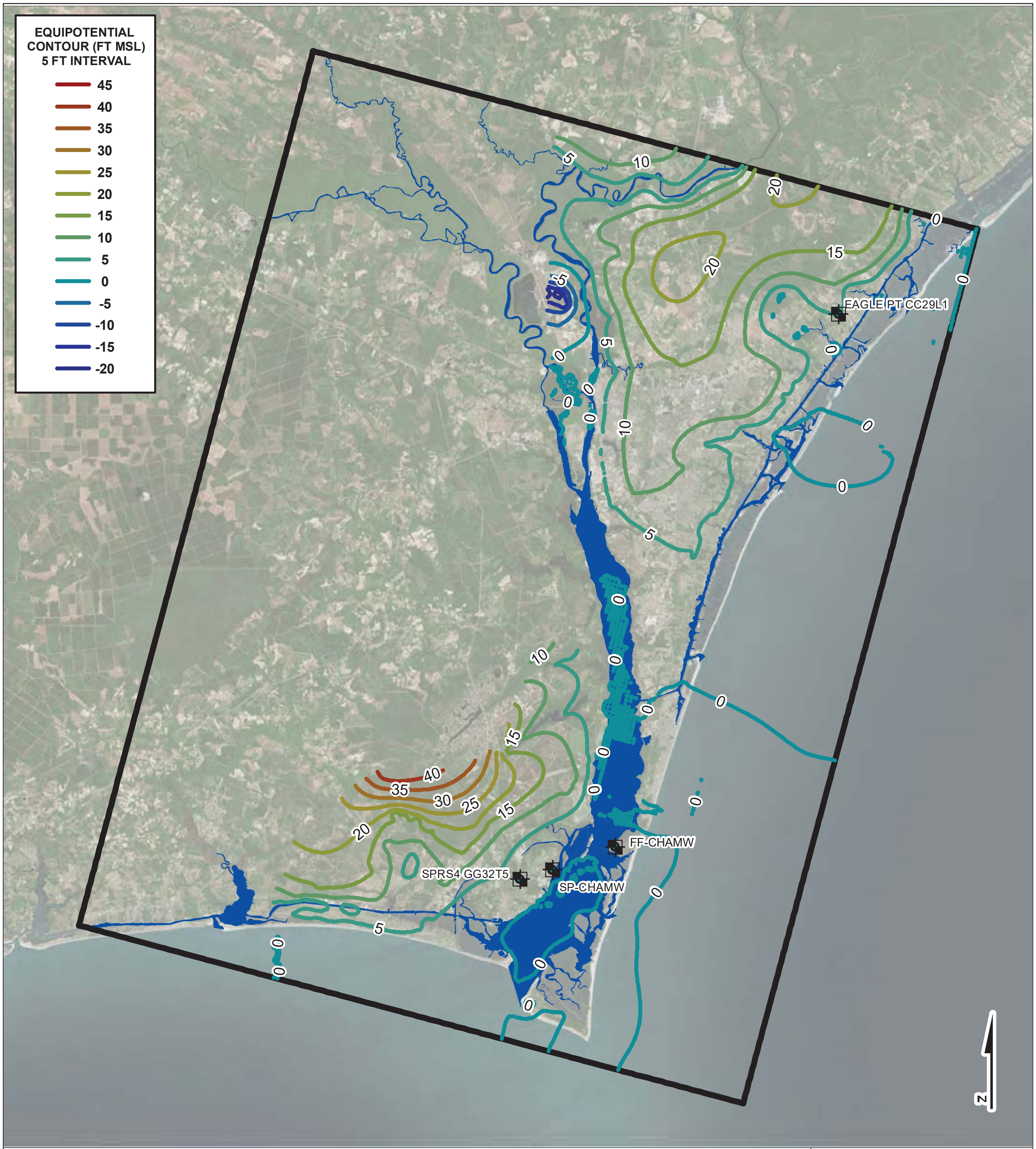
▭ MODEL DOMAIN

✚ SURFICIAL AQUIFER MONITORING WELL

0 32,000
Feet
1 " = 32,000 '

GMA

File: DRAWINGS/16001/ EXISTING_SA_EQPOT.mxd	MODELED POTENTIOMETRIC SURFACE FOR THE SURFICIAL AQUIFER AT THE PRESENT CHANNEL DEPTH	DATE: 11/15/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 13



LEGEND

▭ MODEL DOMAIN

✚ CASTLE HAYNE MONITORING WELLS

0 30,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/160001/
EXISTING_CHA_EQPOT.mxd

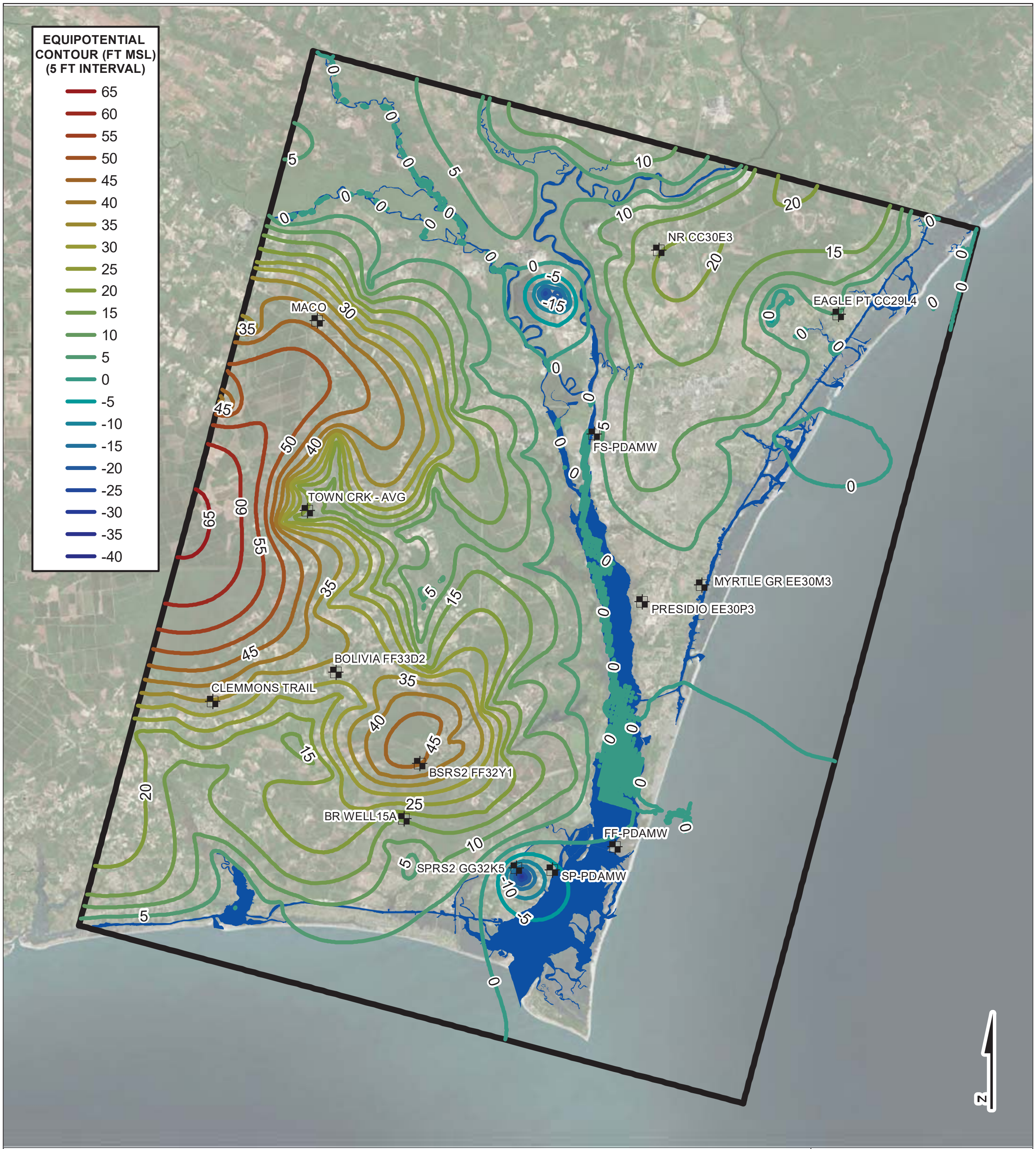
MODELED POTENTIOMETRIC SURFACE FOR THE
CASTLE HAYNE AQUIFER AT THE PRESENT CHANNEL DEPTH

DATE: 11/20/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 14



LEGEND

▭ MODEL DOMAIN

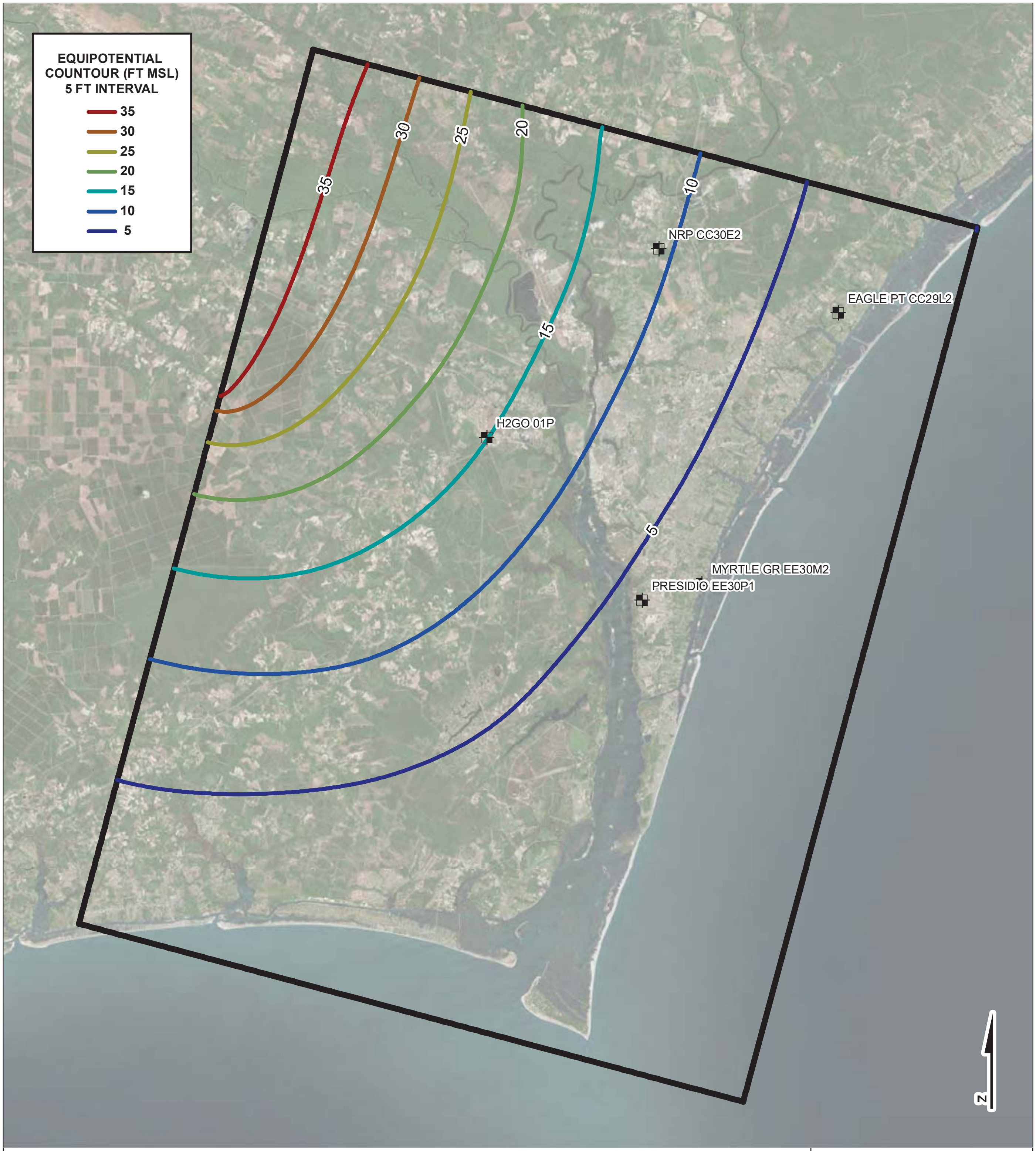
⯐ UPPER PEEDEE MONITORING WELLS

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/160001/ EXISTING_UPDA_EQPOT.mxd	MODELED POTENTIOMETRIC SURFACE FOR THE UPPER PEEDEE AQUIFER AT THE PRESENT CHANNEL DEPTH	DATE: 11/15/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 15



LEGEND

✜ LOWER PEEDEE MONITORING WELLS

▭ MODEL DOMAIN

0 32,000
Feet

1 " = 32,000 '

File: DRAWINGS/160001/
EXISTING_LPDA_EQPOT.mxd

MODELED POTENTIOMETRIC SURFACE FOR THE
LOWER PEEDEE AQUIFER AT THE PRESENT CHANNEL DEPTH

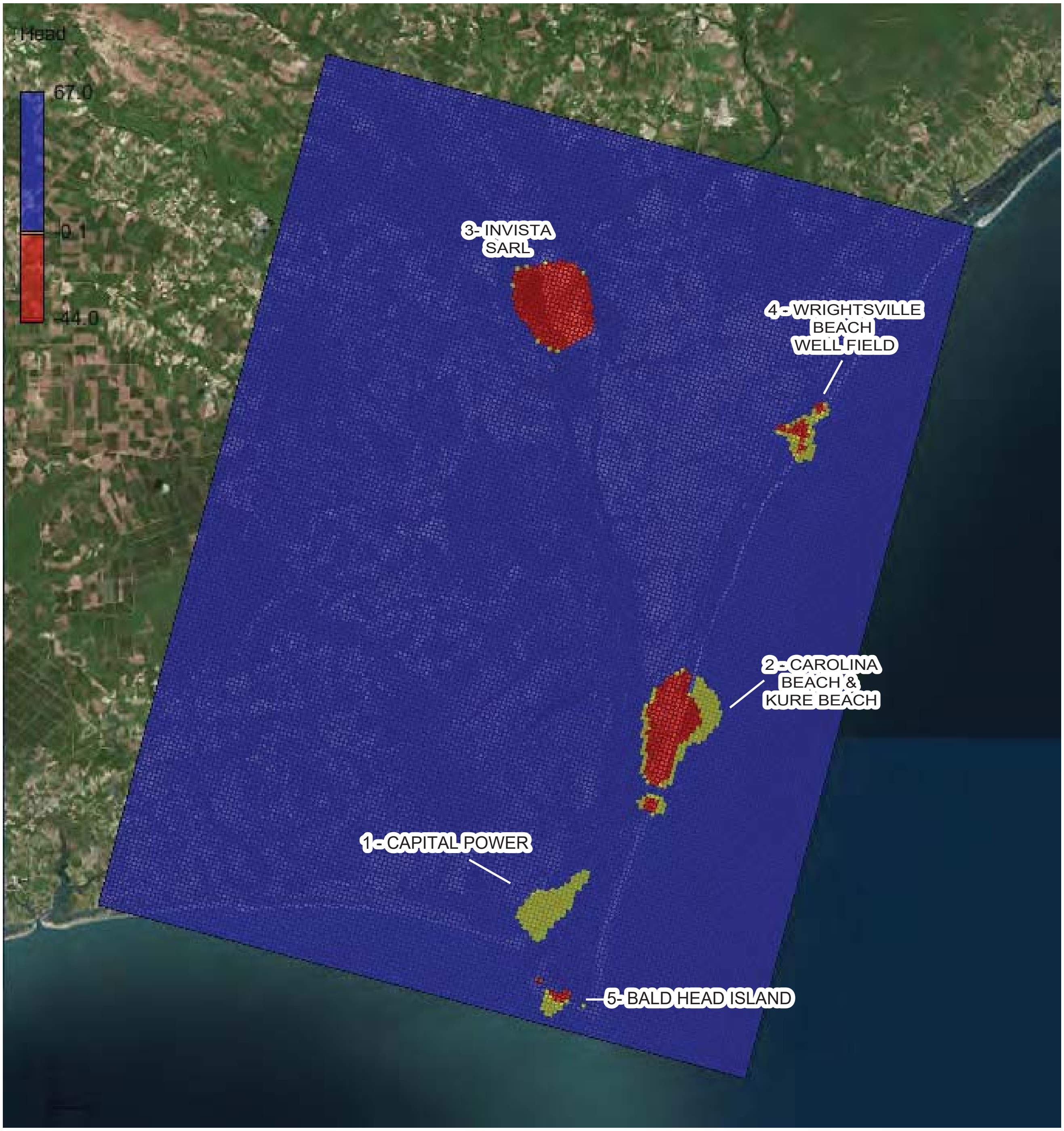
DATE: 11/15/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 16

EXISTING CHANNEL CONFIGURATION



LEGEND

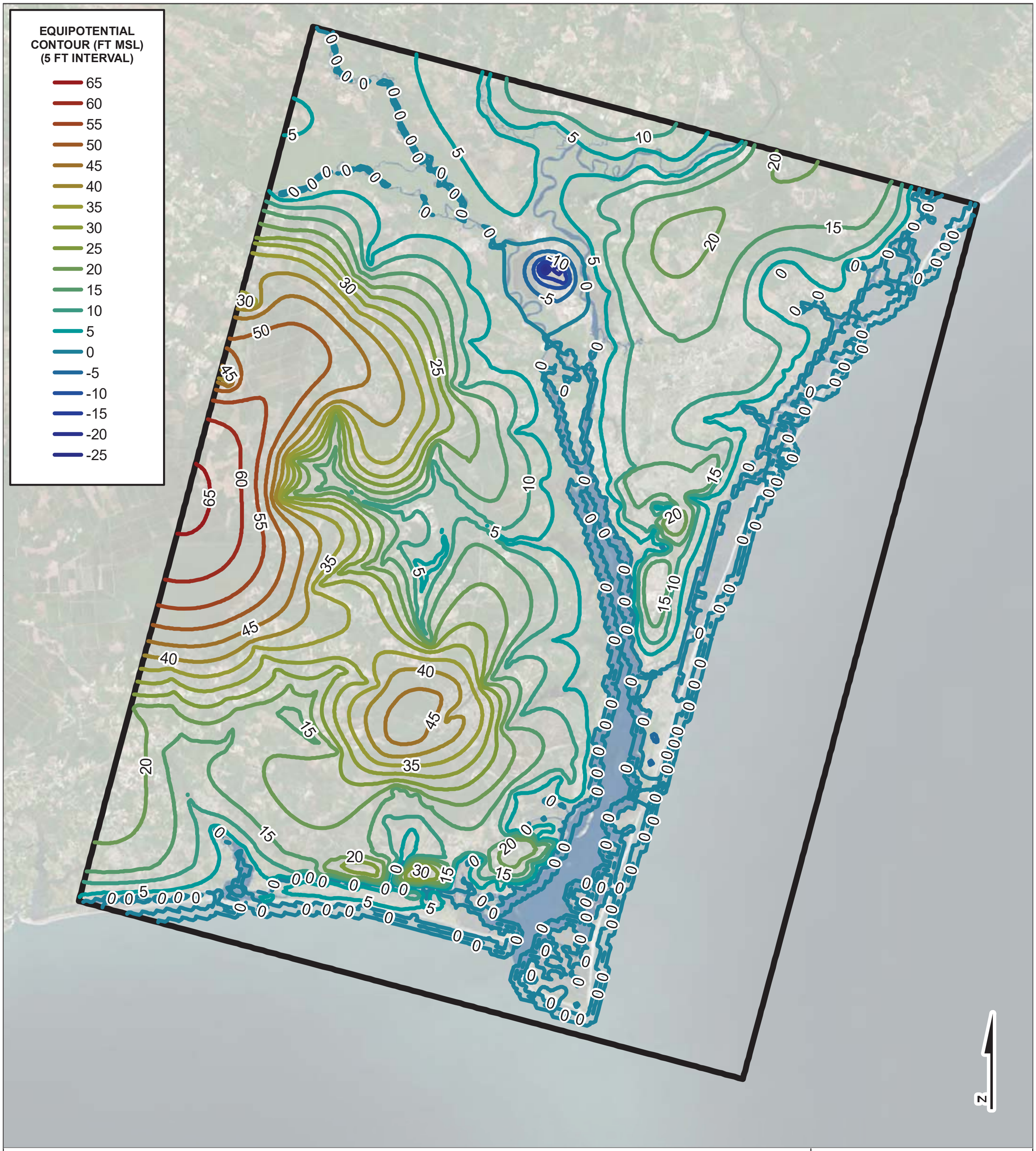
🟦 HEAD ABOVE SEA LEVEL IN LAYER 2

🟨 HEAD LESS THAN 0.1 FEET BELOW SEA LEVEL IN LAYER 2

🟥 HEAD MORE THAN 0.1 FEET BELOW SEA LEVEL IN LAYER 2

GMA

Z:\Drawings\160001\FIG 2.PDF	EXISTING AREAS OF POTENTIAL DOWNWARD MIGRATION OF SURFACE WATER AT THE PRESENT CHANNEL DEPTH	DATE: 2/12/2019
PROJECT: 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 17



LEGEND

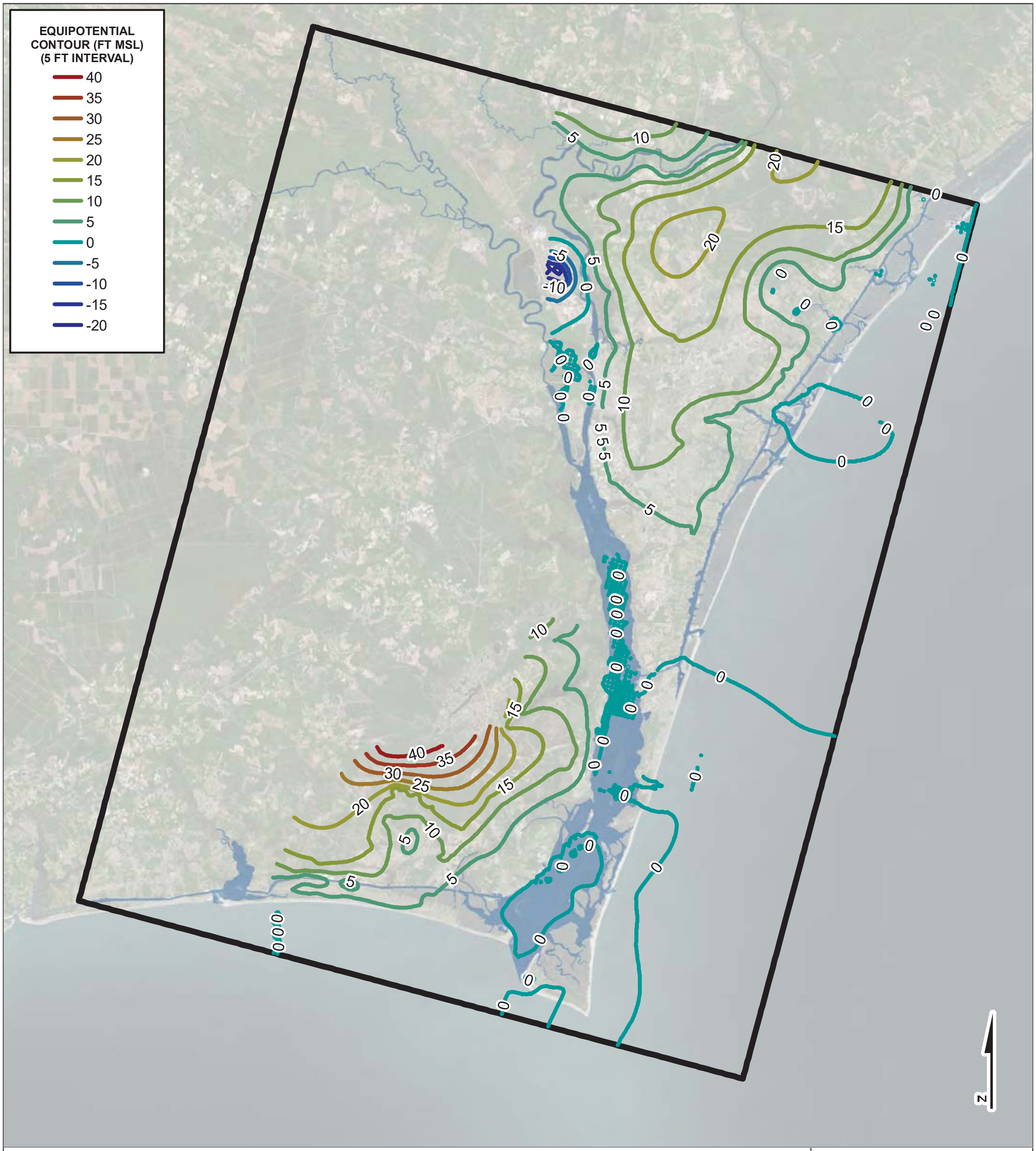
▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/16001/ 47FT_SA_EQPOT.mxd	MODELED POTENTIOMETRIC SURFACE FOR THE SURFICIAL AQUIFER AT A 47-FOOT CHANNEL DEPTH	DATE: 11/26/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 18



LEGEND

▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/16001/
47FT_CHA_EQPOT.mxd

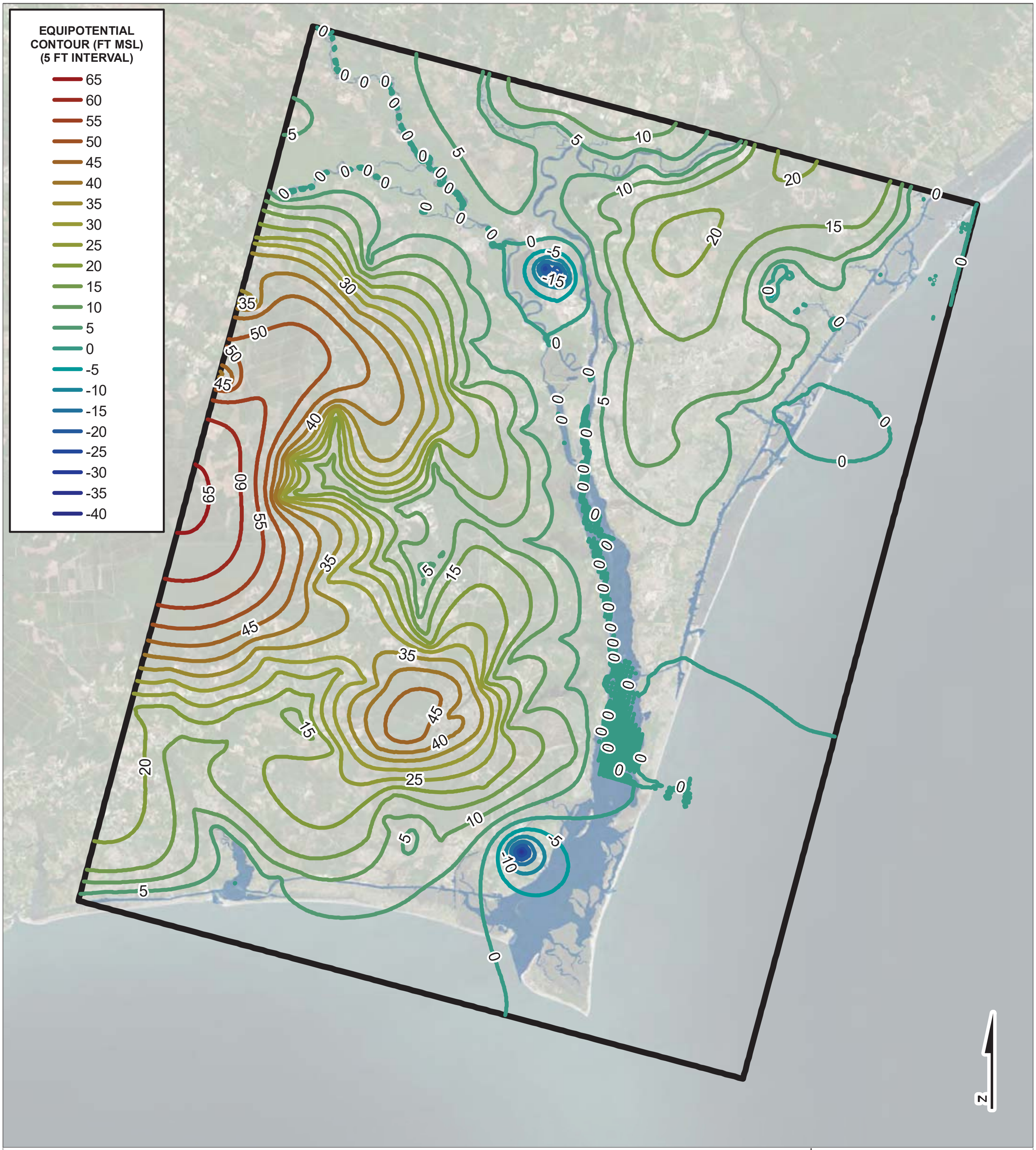
MODELED POTENTIOMETRIC SURFACE FOR THE CASTLE HAYNE
AQUIFER AT A 47-FOOT CHANNEL DEPTH

DATE: 11/27/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 19



LEGEND

▭ MODEL DOMAIN

0 32,000

Feet

1 " = 32,000 '

File: DRAWINGS/16001/
47FT_UPDA_EQPOT.mxd

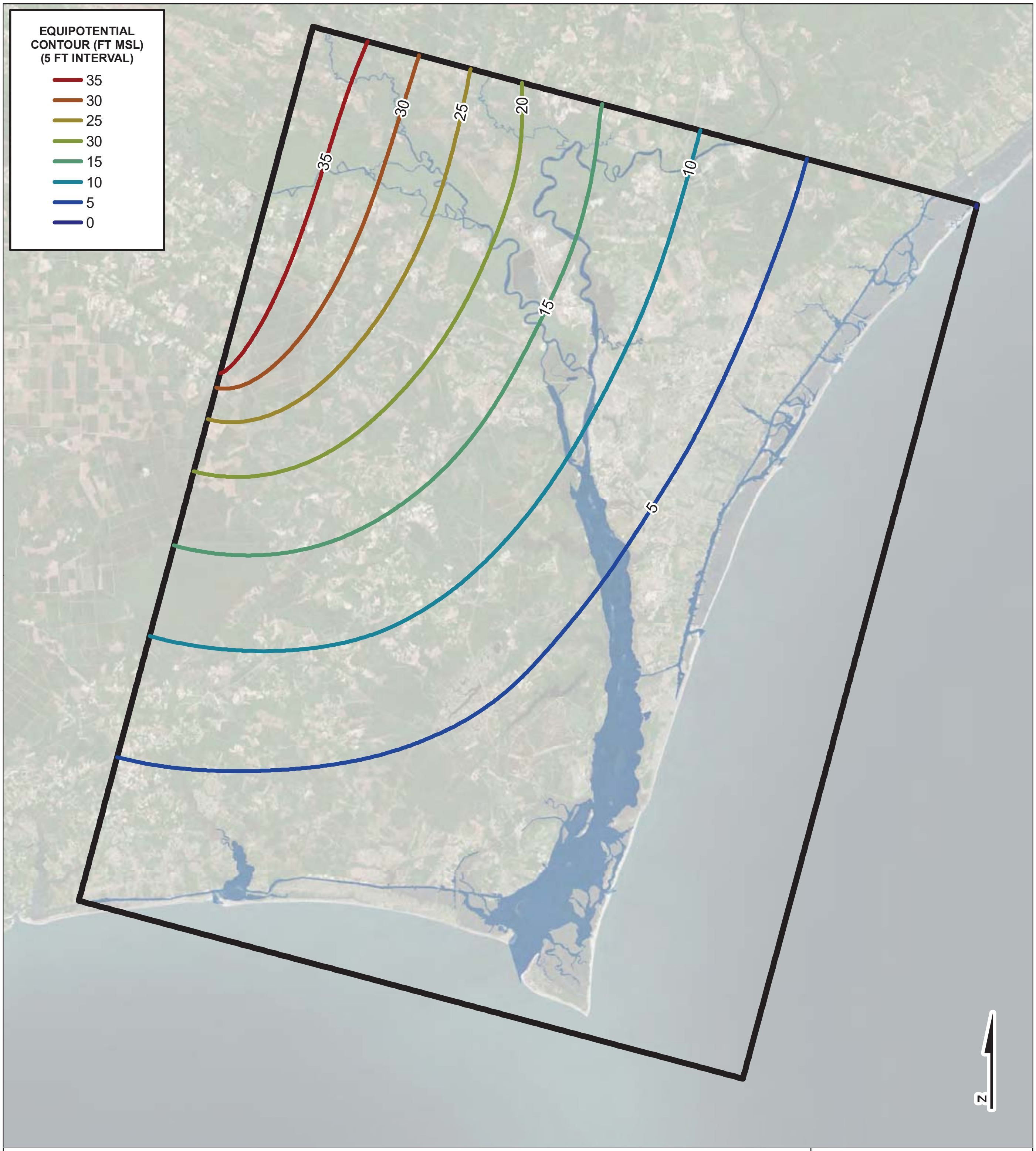
MODELED POTENTIOMETRIC SURFACE FOR THE UPPER PEEDEE AQUIFER AT A 47-FOOT CHANNEL DEPTH

DATE: 11/27/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

FIGURE 20

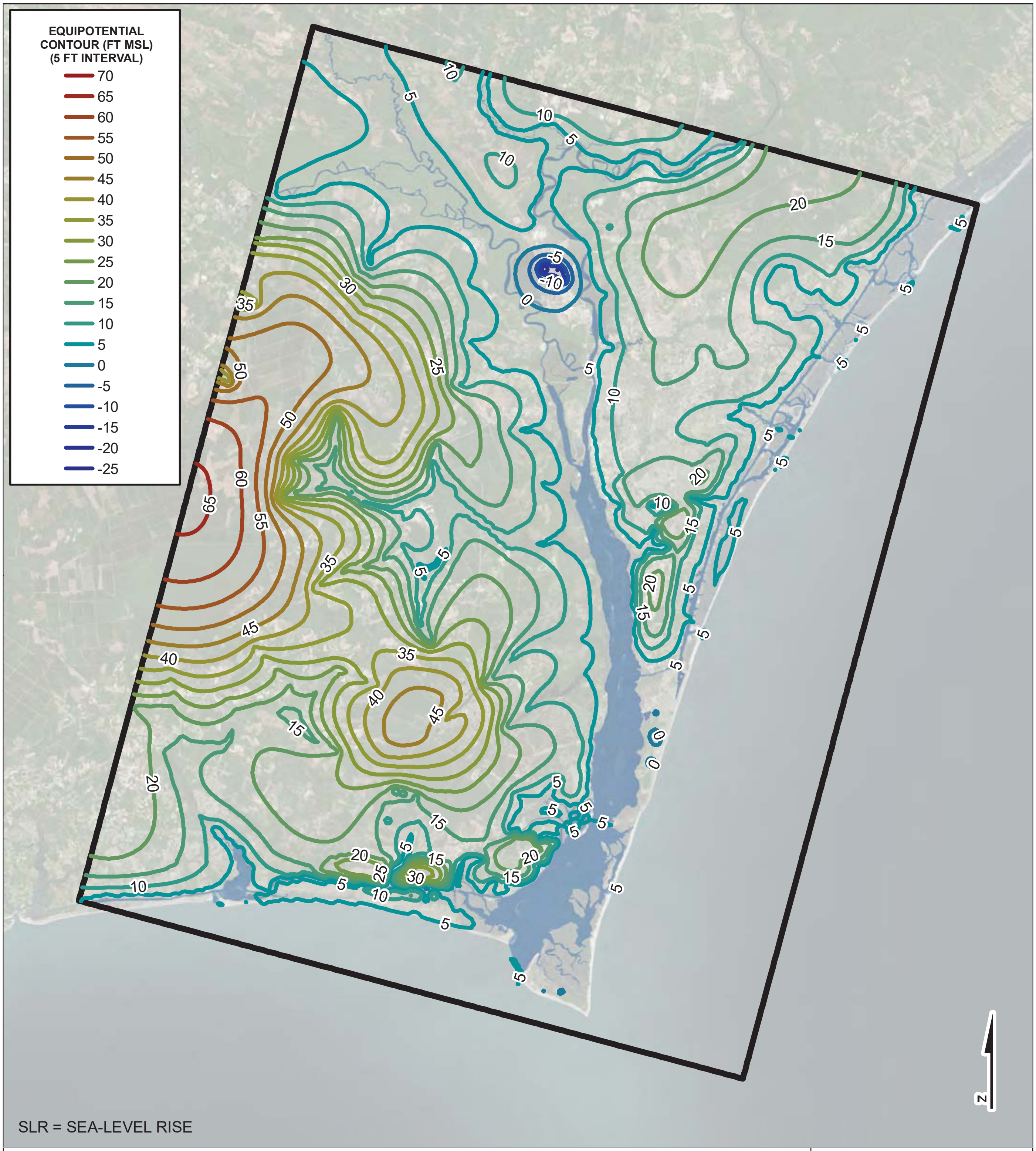


LEGEND

▭ MODEL DOMAIN

0 32,000 Feet
1 " = 32,000 '

File: DRAWINGS/16001/ 47FT_LPDA_EQPOT.mxd	MODELED POTENTIOMETRIC SURFACE FOR THE LOWER PEEDEE AQUIFER AT A 47-FOOT CHANNEL DEPTH	DATE: 11/27/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 21



SLR = SEA-LEVEL RISE

LEGEND

▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/16001/
EXISTING_SLR_SA_EQPOT.mxd

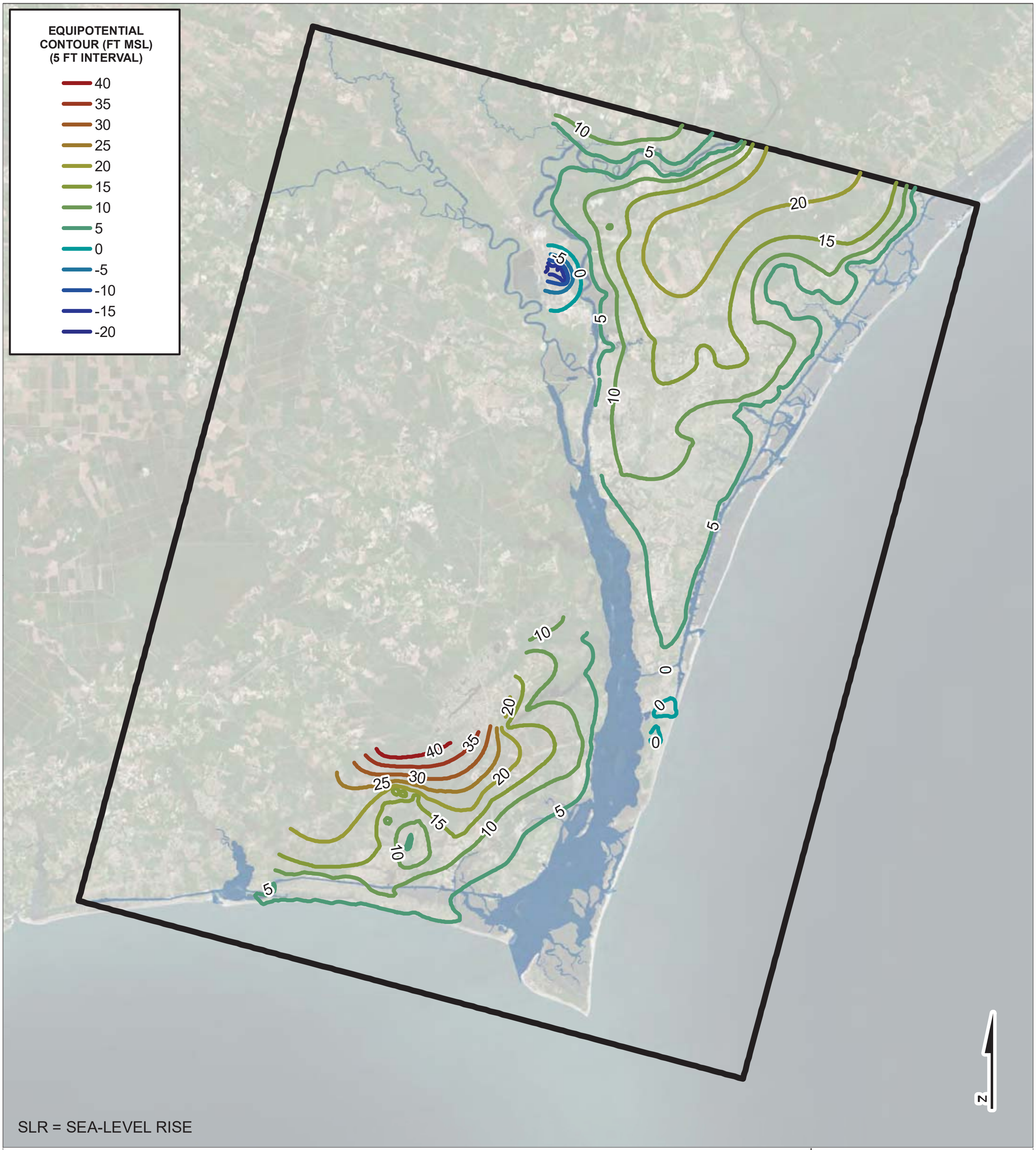
MODELED POTENTIOMETRIC SURFACE FOR THE SURFICIAL AQUIFER
AT THE PRESENT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

DATE: 11/26/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 22



SLR = SEA-LEVEL RISE

LEGEND

▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/16001/
EXISTING_SLR_CHA_EQPOT.mxd

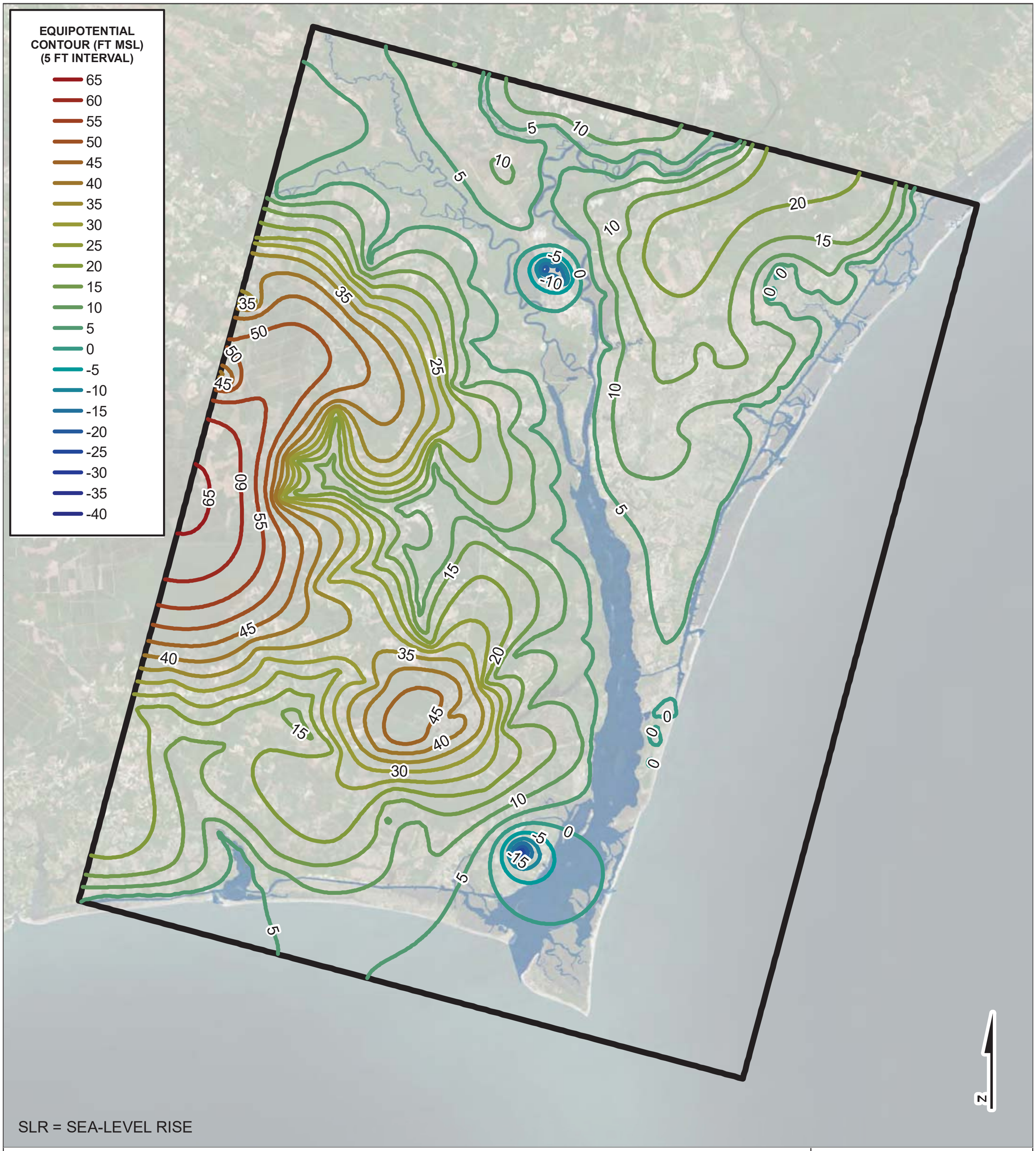
MODELED POTENTIOMETRIC SURFACE FOR THE CASTLE HAYNE AQUIFER AT THE PRESENT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

DATE: 11/26/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

FIGURE 23



LEGEND

▭ MODEL DOMAIN

0 32,000 Feet
1 " = 32,000 '

GMA

File: DRAWINGS/16001/
EXISTING_SLR_UPDA_EQPOT.mxd

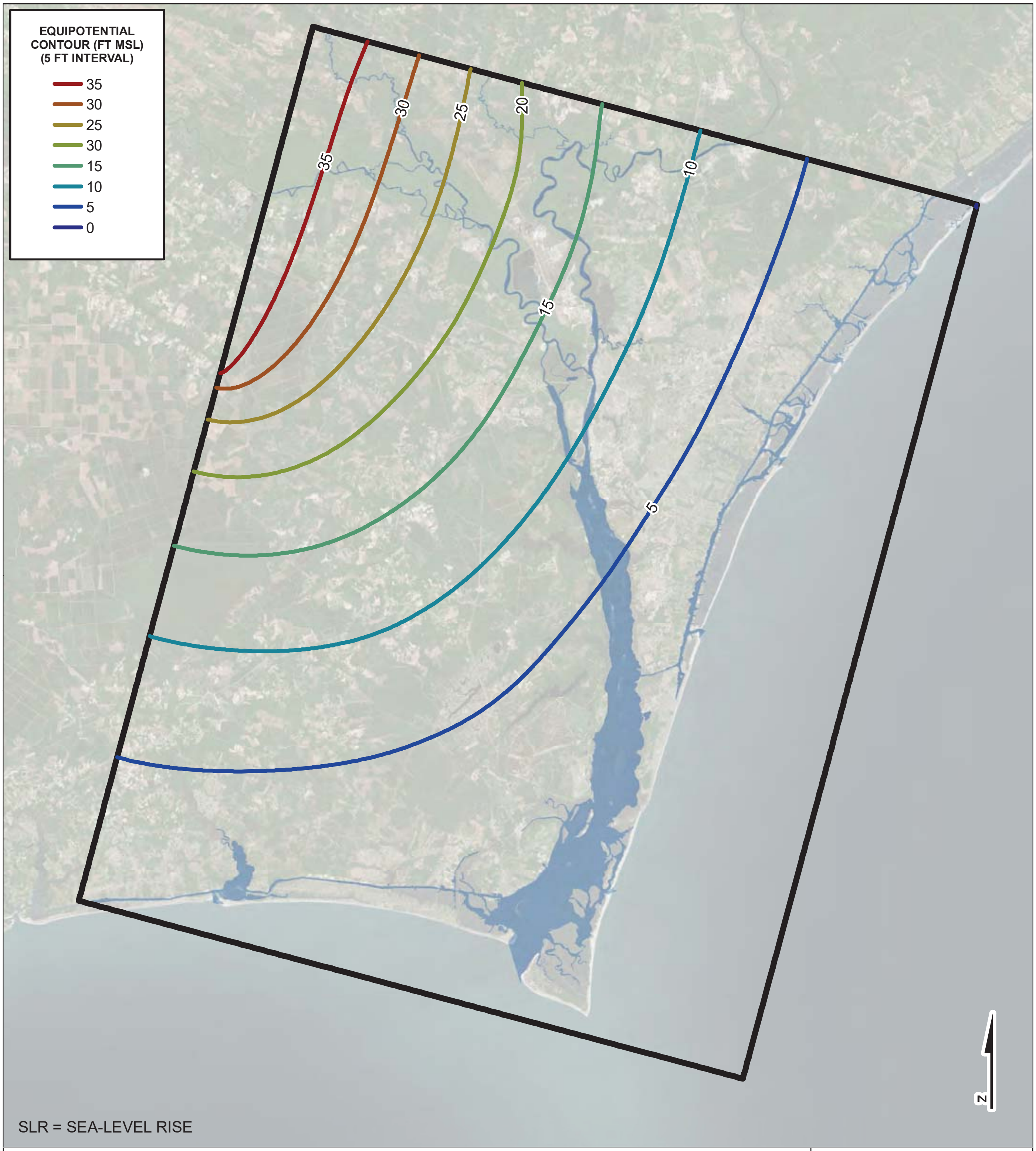
MODELED POTENTIOMETRIC SURFACE FOR THE UPPER PEEDEE
AQUIFER AT THE PRESENT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

DATE: 11/26/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 24



LEGEND

▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/16001/
EXISTING_SLR_LPDA_EQPOT.mxd

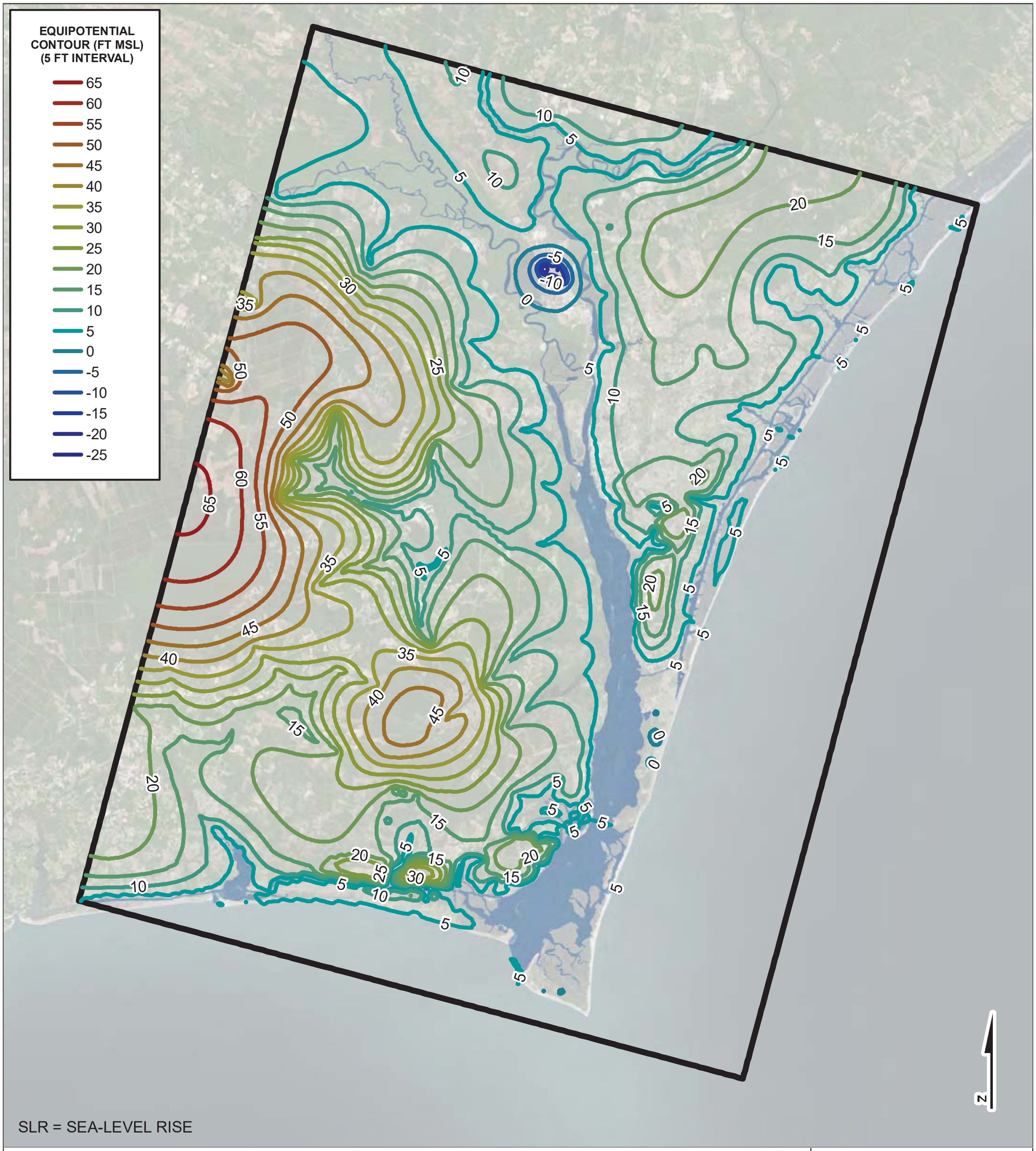
MODELED POTENTIOMETRIC SURFACE FOR THE LOWER PEEDEE AQUIFER AT THE PRESENT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

DATE: 11/26/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

FIGURE 25



SLR = SEA-LEVEL RISE

LEGEND

▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

File: DRAWINGS/160001/
47FT_SLR_SA_EQPOT.mxd

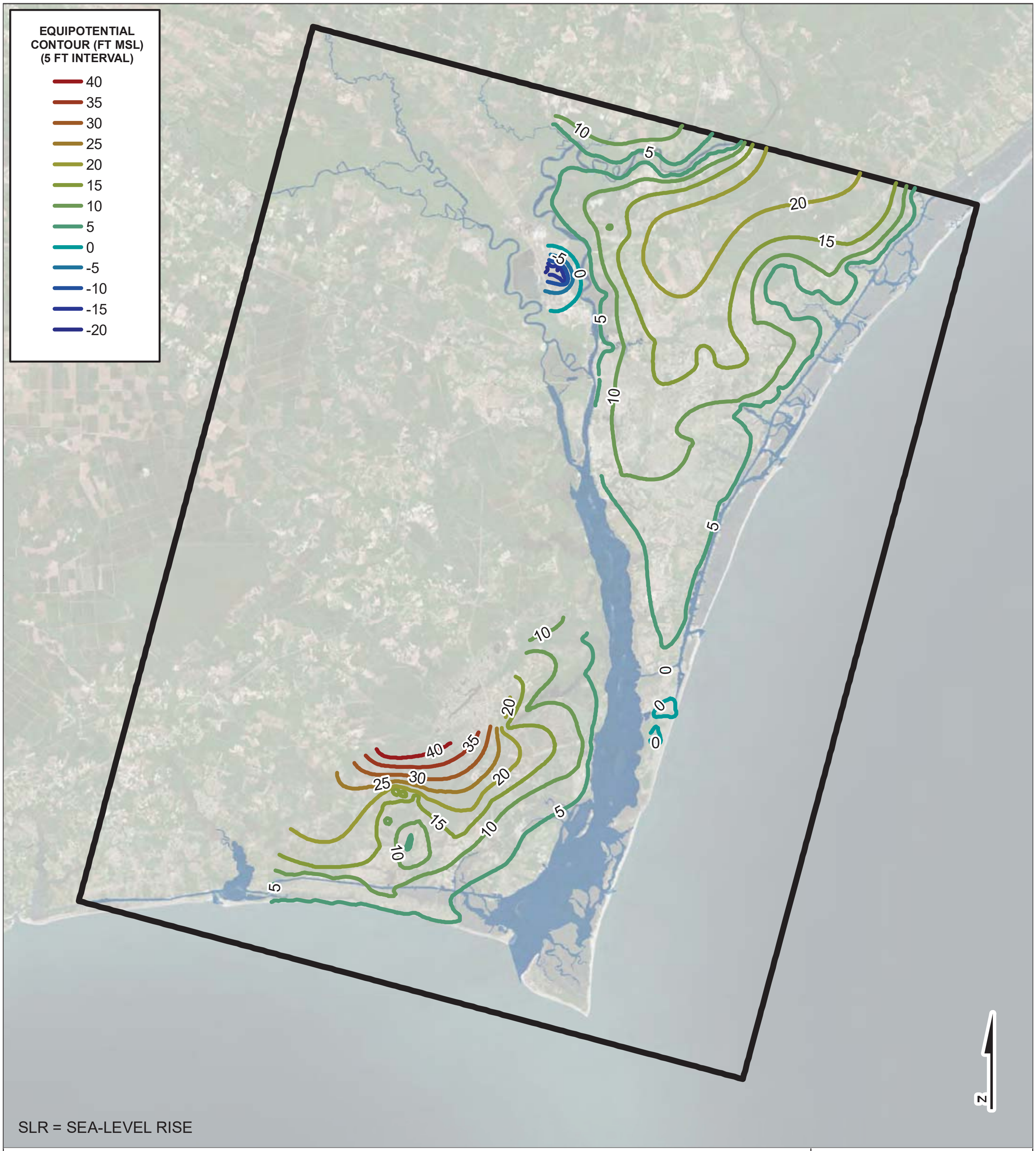
MODELED POTENTIOMETRIC SURFACE FOR THE SURFICIAL AQUIFER
AT A 47-FOOT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

DATE: 11/27/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 26



SLR = SEA-LEVEL RISE

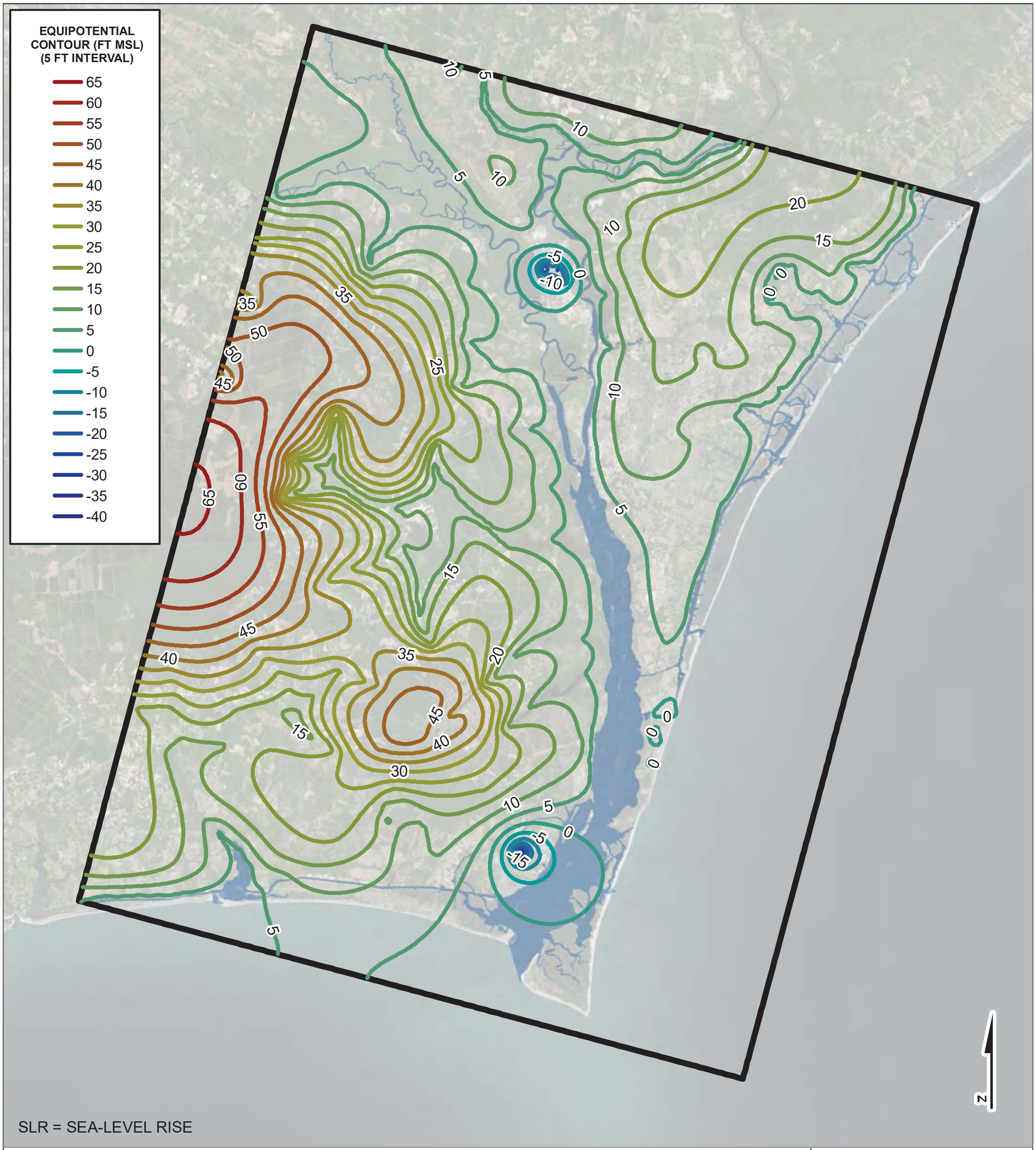
LEGEND

▭ MODEL DOMAIN

0 32,000
Feet
1 " = 32,000 '

GMA

File: DRAWINGS/160001/ 47FT_SLR_CHA_EQPOT.mxd	MODELED POTENTIOMETRIC SURFACE FOR THE CASTLE HAYNE AQUIFER AT A 47-FOOT CHANNEL DEPTH UNDER 2.56 FEET OF SLR	DATE: 11/27/2018
PROJECT NO. 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 27



SLR = SEA-LEVEL RISE

LEGEND

▭ MODEL DOMAIN

0 32,000 Feet

1 " = 32,000 '

GMA

File: DRAWINGS/160001/
47FT_SLR_UPDA_EQPOT.mxd

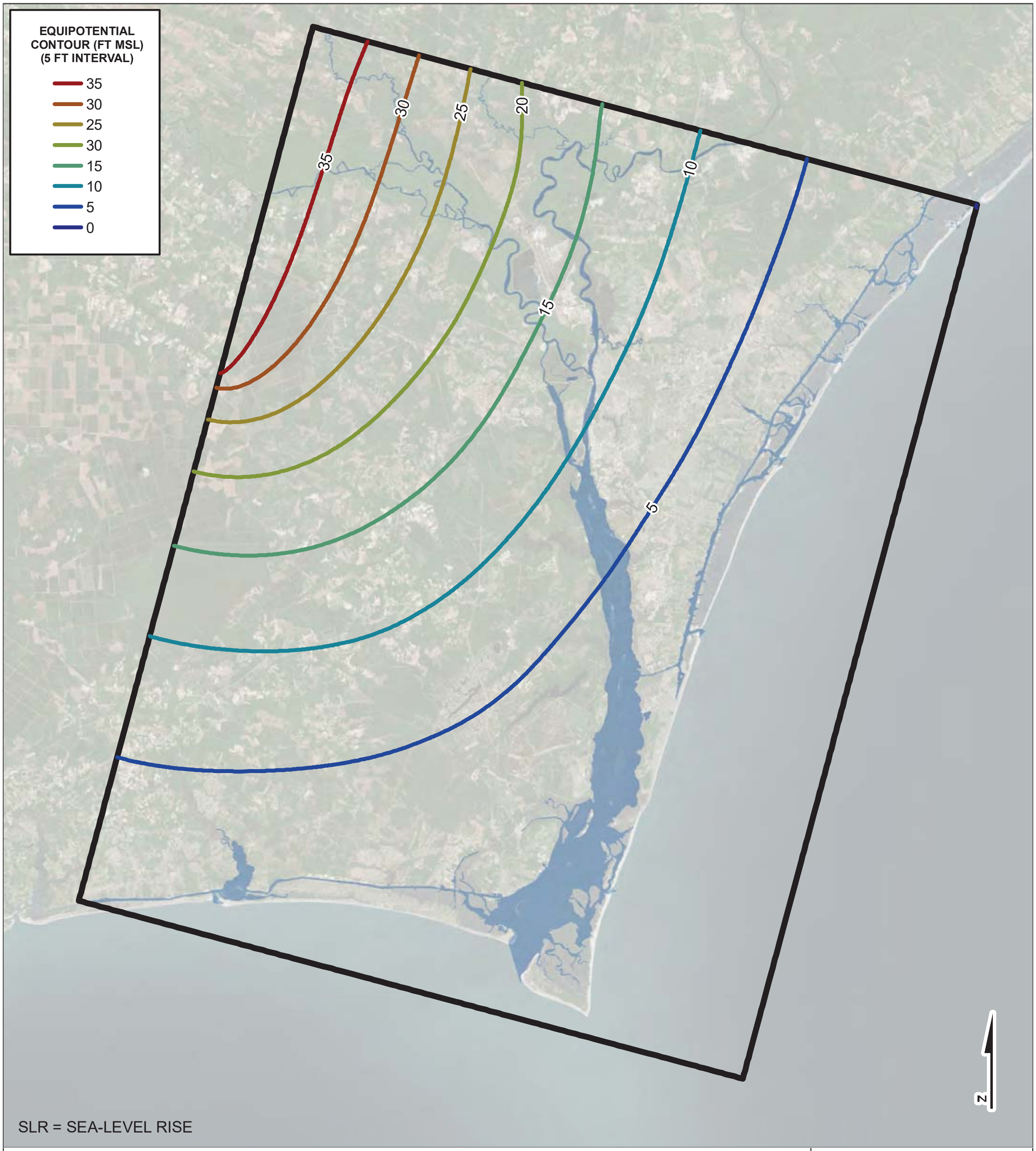
MODELED POTENTIOMETRIC SURFACE FOR THE UPPER PEEDEE AQUIFER AT A 47-FOOT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

DATE: 11/27/2018

PROJECT NO. 160001

PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT

FIGURE 28



SLR = SEA-LEVEL RISE

LEGEND

▭ MODEL DOMAIN

0 32,000
Feet
1 " = 32,000 '

GMA

File: DRAWINGS/160001/
47FT_SLR_LPDA_EQPOT.mxd

MODELED POTENTIOMETRIC SURFACE FOR THE LOWER PEEDEE
AQUIFER AT A 47-FOOT CHANNEL DEPTH UNDER 2.56 FEET OF SLR

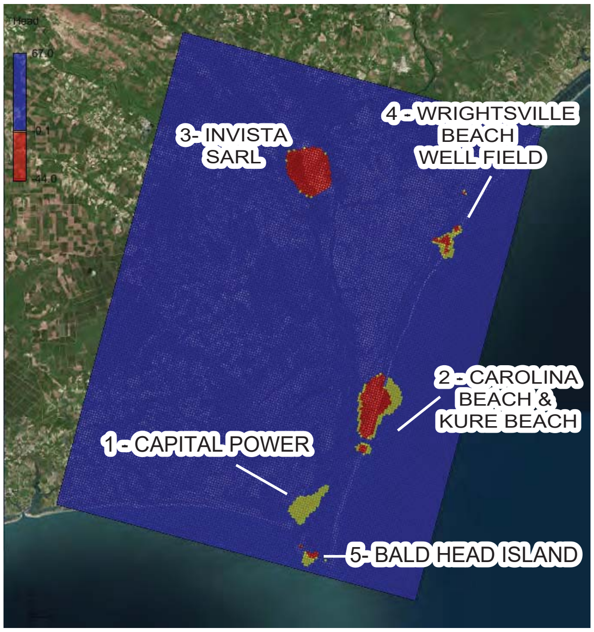
DATE: 11/27/2018

PROJECT NO. 160001

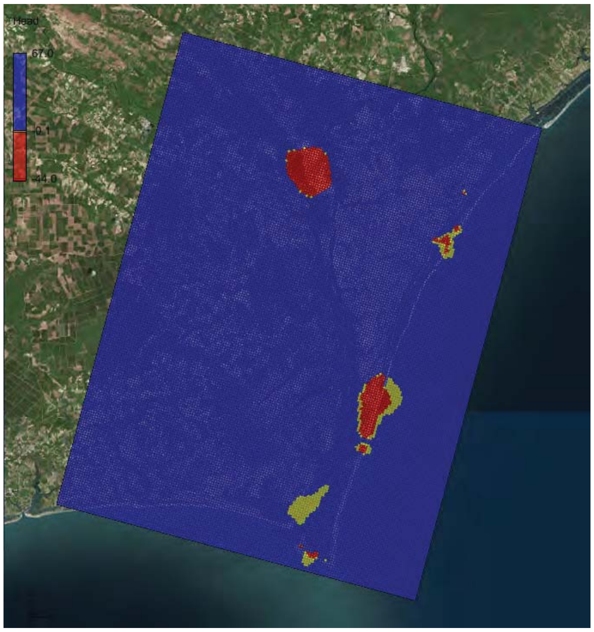
PORT OF WILMINGTON SECTION 203 NAVIGATION
CHANNEL IMPROVEMENT

FIGURE 29

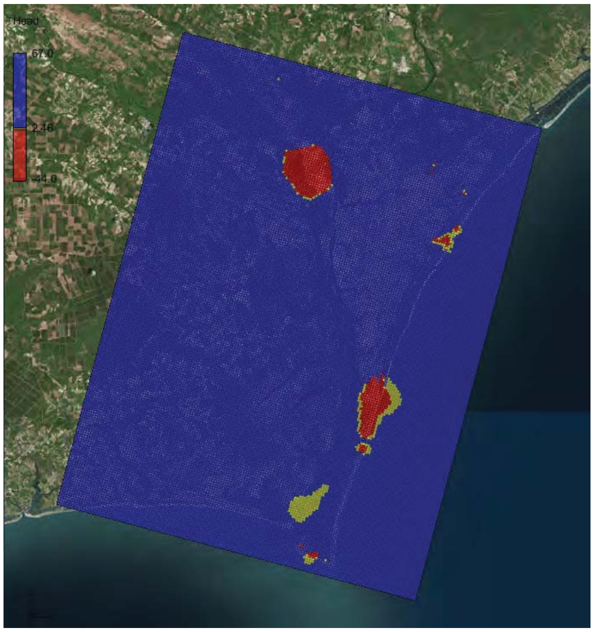
EXISTING CHANNEL CONFIGURATION



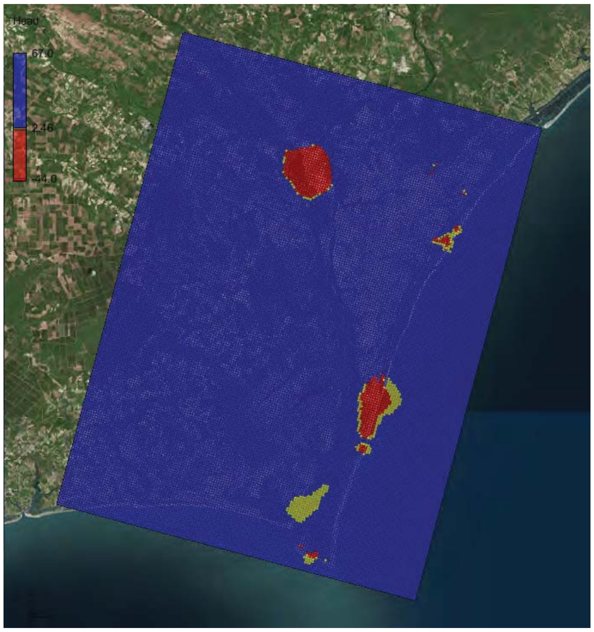
47-FOOT CHANNEL DEPTH



EXISTING CHANNEL CONFIGURATION WITH 2.56 FOOT INCREASE IN SEA LEVEL



47-FOOT CHANNEL DEPTH WITH 2.56 FOOT INCREASE IN SEA LEVEL

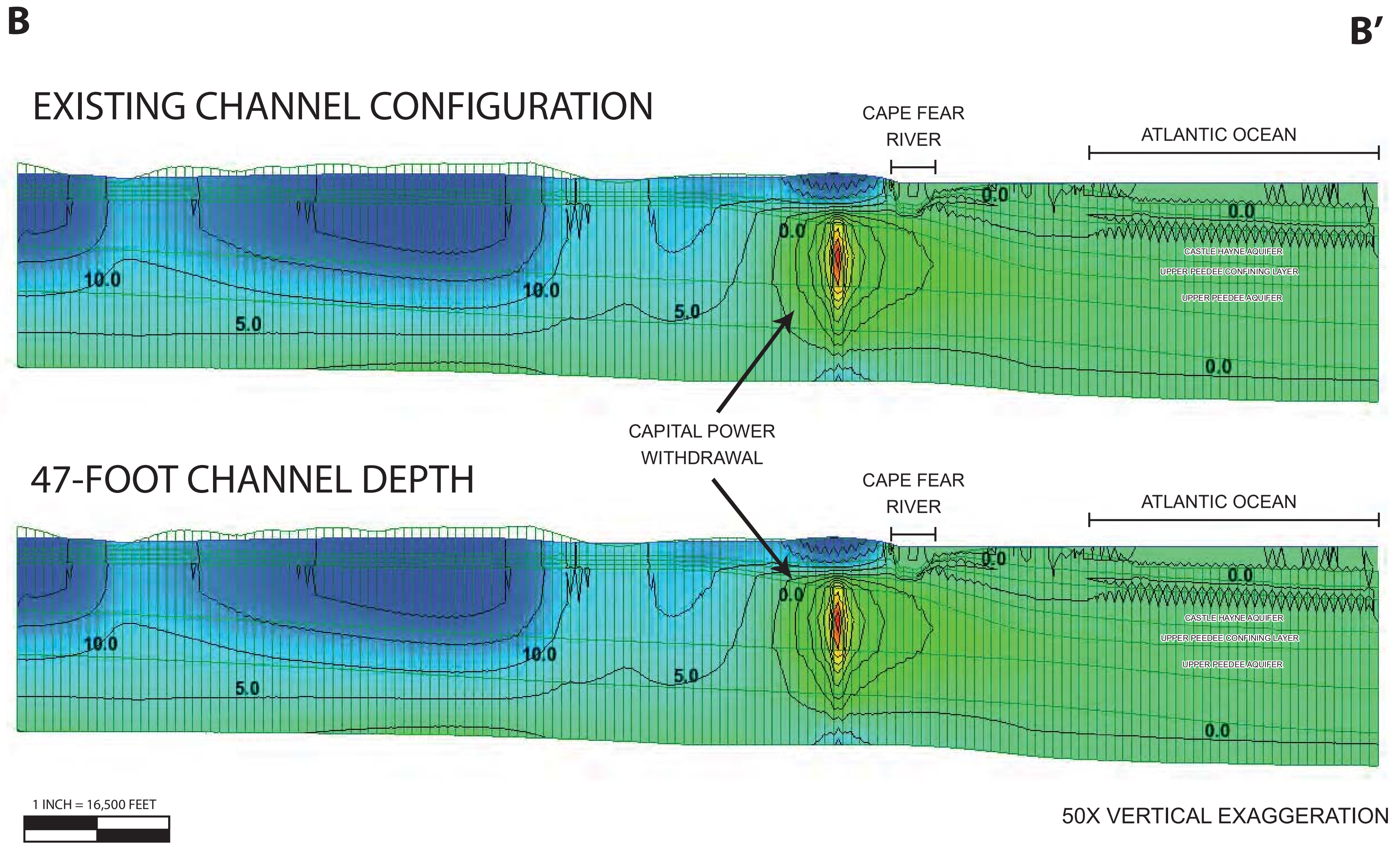


LEGEND

🟦	HEAD ABOVE SEA LEVEL IN LAYER 2
🟨	HEAD LESS THAN 0.1 FEET BELOW SEA LEVEL IN LAYER 2
🟥	HEAD MORE THAN 0.1 FEET BELOW SEA LEVEL IN LAYER 2

GMA

Z:\Drawings\160001\FIG 2.PDF	COMPARISON OF AREAS OF POTENTIAL DOWNWARD MIGRATION OF SURFACE WATER	DATE: 2/12/2019
PROJECT: 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 30

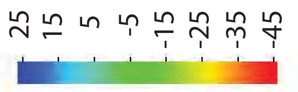


EXISTING CHANNEL CONFIGURATION

47-FOOT CHANNEL DEPTH

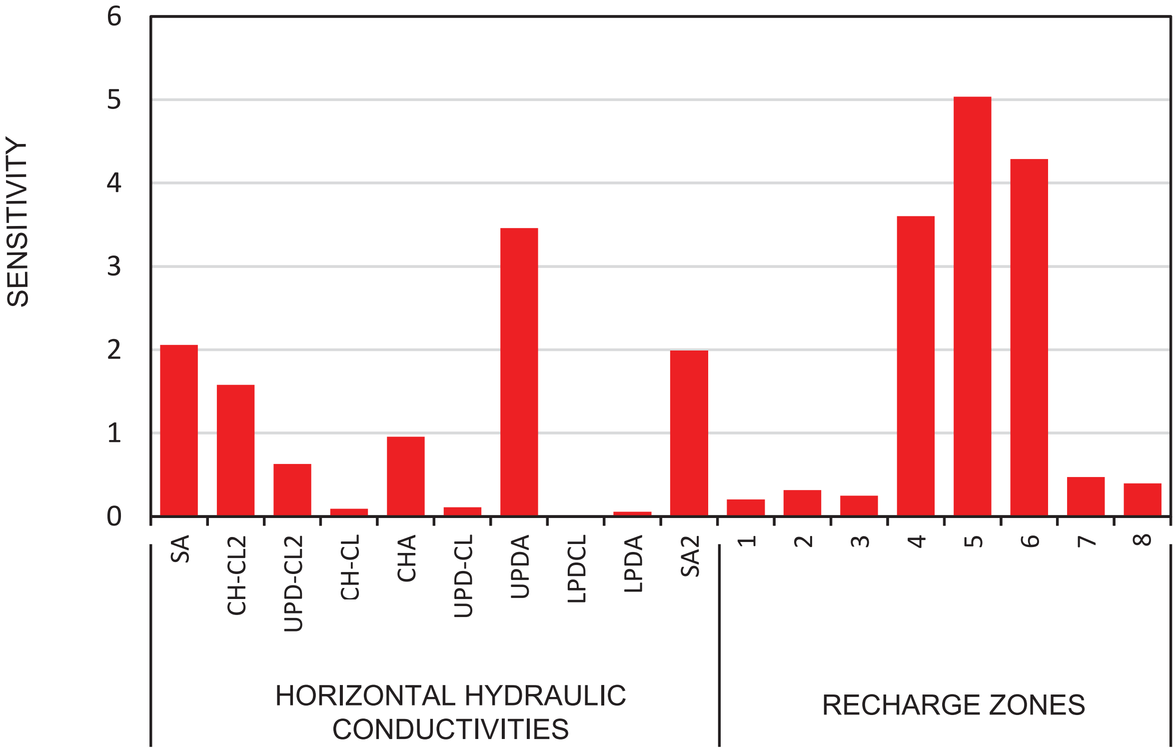
-LEGEND-

HEAD (FT MSL)



GROUNDWATER MANAGEMENT ASSOCIATES, INC.

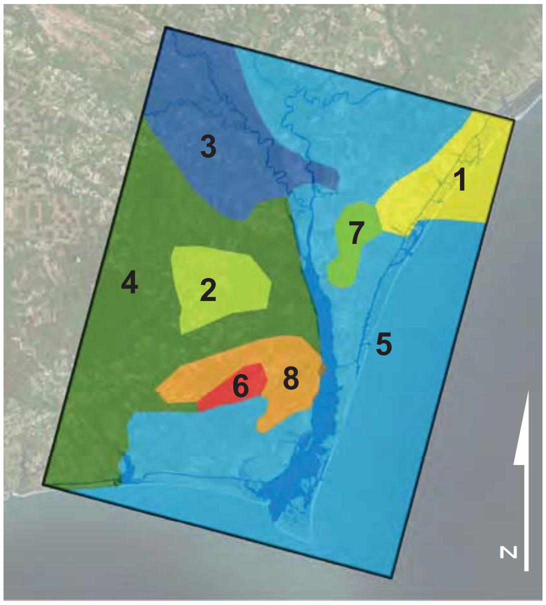
File: DRAWINGS/160001/ VERT_COMP.PDF	MODEL PROFILES IN THE SOUTHPORT REGION BEFORE AND AFTER THE PROPOSED CHANNEL MODIFICATION	DATE: 2/13/2019
PROJECT 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 31



LAYER ABBREVIATIONS

SA = SURFICIAL AQUIFER
CHCL = CASTLE HAYNE CONFINING LAYER
CHCA = CASTLE HAYNE AQUIFER
UPDCL = UPPER PEEDEE CONFINING LAYER
UPDA = UPPER PEEDEE AQUIFER
LPDCL = LOWER PEEDEE CONFINING LAYER
LPDA = LOWER PEEDEE AQUIFER

RECHARGE ZONES



GMA

Z:\Drawings\160001\FIG 32 SENSITIVITY.pdf	SENSITIVITY ANALYSIS	DATE: 11/29/2018
PROJECT: 160001	PORT OF WILMINGTON SECTION 203 NAVIGATION CHANNEL IMPROVEMENT	FIGURE 32

APPENDICES

Well Map ID	Well Name	OWNER	X Coordinate (NC State Plane, ft)	Y Coordinate (NC State Plane, ft)	Elevation of Top of Screen (ft MSL)	Elevation of Bottom of Screen (ft MSL)	Average Daily Pumping (MGD)	Average Daily Pumping (ft^3/day)
P1	Southport Plant 789 - Construction Well	ARCHER DANIELS MIDLAND CO.	2304584	71451	-80	-120	0.02263	-3025
P3	Central #1	BALD HEAD ISLAND	2302783	43235	-38	-48	0.011178	-1494
P4	Central #2	BALD HEAD ISLAND	2303098	43005	-38	-48	0.016384	-2190
P7	Edward Teach #1	BALD HEAD ISLAND	2305543	40980	-45	-55	0.012055	-1611
P8	Edward Teach #2	BALD HEAD ISLAND	2308364	40308	-37	-47	0.017644	-2359
P11	Federal #1	BALD HEAD ISLAND	2309769	40634	-43	-53	0.014466	-1934
P12	Federal #2	BALD HEAD ISLAND	2310032	40351	-41	-51	0.023014	-3076
P13	Federal #3	BALD HEAD ISLAND	2313687	37327	-36	-42	0.01611	-2154
P14	Laughing Gull	BALD HEAD ISLAND	2305939	40491	-39	-49	0.014959	-2000
P16	Muscadine #1	BALD HEAD ISLAND	2307036	39705	-32	-42	0.014466	-1934
P17	Muscadine #2	BALD HEAD ISLAND	2307478	39712	-38	-48	0.015534	-2077
P18	Office Well	BALD HEAD ISLAND	2308417	39279	-34	-44	0.013151	-1758
P21	Royal James #1	BALD HEAD ISLAND	2305100	43463	-43	-53	0.008384	-1121
P22	SOUTHPORT CHA-1	BRUNSWICK CO. WATER SYSTEM	2275012	82021	-40	-120	0.115726	-15470
P23	SOUTHPORT CHA-11	BRUNSWICK CO. WATER SYSTEM	2270239	79323	-13	-112	0.458301	-61266
P24	SOUTHPORT CHA-12	BRUNSWICK CO. WATER SYSTEM	2270005	82222	-10	-46	0.264986	-35424
P25	SOUTHPORT CHA-12-A	BRUNSWICK CO. WATER SYSTEM	2270198	83882	-10	-60	0.138082	-18459
P26	SOUTHPORT CHA-15	BRUNSWICK CO. WATER SYSTEM	2274281	85098	-20	-70	0.306082	-40917
P27	SOUTHPORT CHA-16	BRUNSWICK CO. WATER SYSTEM	2277412	84271	-15	-105	0.282	-37698
P28	SOUTHPORT CHA-17	BRUNSWICK CO. WATER SYSTEM	2280616	83148	-16	-106	0.092164	-12321
P29	SOUTHPORT CHA-18	BRUNSWICK CO. WATER SYSTEM	2282682	84826	-19	-109	0.044712	-5977
P30	SOUTHPORT CHA-19	BRUNSWICK CO. WATER SYSTEM	2284346	85049	-19	-99	0.083836	-11207
P31	SOUTHPORT CHA-2	BRUNSWICK CO. WATER SYSTEM	2277092	82300	-9	-109	0.078386	-10479
P32	SOUTHPORT CHA-3	BRUNSWICK CO. WATER SYSTEM	2277529	79182	-28	-113	0.114247	-15273
P33	SOUTHPORT CHA-5	BRUNSWICK CO. WATER SYSTEM	2277779	74623	-28	-108	0.044055	-5889
P34	SOUTHPORT CHA-6A	BRUNSWICK CO. WATER SYSTEM	2277758	76903	-55	-115	0.153	-20453
P35	SOUTHPORT CHA-8	BRUNSWICK CO. WATER SYSTEM	2272344	86323	-13	-98	0.562192	-75154
P36	AA	CAPE INDUSTRIES (Invista Sarl)	2310404	201435	-33	-63	0.214	-28608
P37	B2	CAPE INDUSTRIES (Invista Sarl)	2309604	202304	-38	-68	0.090411	-12086

Well Map ID	Well Name	OWNER	X Coordinate (NC State Plane, ft)	Y Coordinate (NC State Plane, ft)	Elevation of Top of Screen (ft MSL)	Elevation of Bottom of Screen (ft MSL)	Average Daily Pumping (MGD)	Average Daily Pumping (ft^3/day)
P38	H2	CAPE INDUSTRIES (Invista Sarl)	2305754	204213	-25	-65	0.140444	-18775
P39	0G2	CAPE INDUSTRIES (Invista Sarl)	2306097	203649	-33	-53	0.262356	-35072
P40	C	CAPE INDUSTRIES (Invista Sarl)	2308703	203540	-28	-58	0.211644	-28293
P41	Well#1	CAPITAL POWER CORP	2295952	71989	-80	-120	0.115	-15373
P42	Well#2	CAPITAL POWER CORP	2295942	71979	-80	-120	0.374	-49997
P43	Well#3	CAPITAL POWER CORP	2295932	71969	-80	-120	0.23	-30747
P44	Well#4	CAPITAL POWER CORP	2295922	71959	-80	-120	0.072	-9625
P45	Well#5	CAPITAL POWER CORP	2295912	71949	-80	-120	0.329	-43981
P48	A-PD-PW	CFPUA WELLFIELD	2357336	197829	-91	-128	0.30614	-40925
P51	C-PD-PW	CFPUA WELLFIELD	2358553	200997	-88	-119	0.168074	-22468
P52	C-CH-PW	CFPUA WELLFIELD	2358543	200987	0	-40	0.074318	-9935
P53	F-CH-PW	CFPUA WELLFIELD	2360074	203110	-6	-46	0.153699	-20547
P54	F-PD-PW	CFPUA WELLFIELD	2360064	203100	-91	-124	0.196373	-26251
P55	G-PD-PW	CFPUA WELLFIELD	2358488	202076	-86	-126	0.124767	-16679
P56	G-CH-PW	CFPUA WELLFIELD	2358478	202066	3	-37	0.068973	-9220
P57	H-CH-PW	CFPUA WELLFIELD	2358432	203294	-4	-44	0.059836	-7999
P58	H-PD-PW	CFPUA WELLFIELD	2358422	203284	-91	-129	0.140499	-18782
P59	I-CH-PW	CFPUA WELLFIELD	2361713	202223	3	-37	0.05749	-7685
P60	I-PD-PW	CFPUA WELLFIELD	2361703	202213	-101	-128	0.14737	-19700
P61	J-PD-PW	CFPUA WELLFIELD	2361663	203792	-93	-126	0.119852	-16022
P62	J-CH-PW	CFPUA WELLFIELD	2361653	203782	-3	-43	0.140959	-18843
P63	K-PD-PW	CFPUA WELLFIELD	2357082	198968	-90	-130	0.151074	-20196
P64	K-CH-PW	CFPUA WELLFIELD	2357072	198958	-7	-47	0.025644	-3428
P65	L-CH-PW	CFPUA WELLFIELD	2357019	200355	-9	-29	0.079595	-10640
P66	L-PD-PW	CFPUA WELLFIELD	2357009	200345	-92	-137	0.144238	-19282
P67	M-PD-PW	CFPUA WELLFIELD	2353051	191124	-95	-130	0.159181	-21279
P68	N-PD-PW	CFPUA WELLFIELD	2354557	191689	-91	-126	0.050482	-6748
P69	O-PD-PW	CFPUA WELLFIELD	2353783	193340	-91	-125	0.117101	-15654
P70	P-PD-PW	CFPUA WELLFIELD	2352097	192369	-88	-116	0.094211	-12594
P71	Q-PD-PW	CFPUA WELLFIELD	2357112	196880	-99	-134	0.241447	-32277

Well Map ID	Well Name	OWNER	X Coordinate (NC State Plane, ft)	Y Coordinate (NC State Plane, ft)	Elevation of Top of Screen (ft MSL)	Elevation of Bottom of Screen (ft MSL)	Average Daily Pumping (MGD)	Average Daily Pumping (ft^3/day)
P72	Well 5	CORNING INC	2341876	183801	-90	-115	0.000986	-132
P73	Well 4	CORNING INC	2342069	184177	-81	-106	0.161468	-21585
P74	Well 3	CORNING INC	2341849	184385	-86	-126	0.001578	-211
P75	Well 2	CORNING INC	2341753	184890	-75	-95	0.118208	-15802
P76	Well 1	CORNING INC	2341232	185036	-76	-96	0.012329	-1648
P77	Well 6A	CP&L SUTTON PLANT	2309533	195790	-29	-59	0.001	-134
P79	Well 5	CP&L SUTTON PLANT	2308885	195862	-30	-60	0.002	-267
P80	Well 6D	CP&L SUTTON PLANT	2309510	195554	-31	-61	0.011	-1470
P81	Well 6E	CP&L SUTTON PLANT	2309260	195210	-36	-66	0.014	-1872
P84	RW-1	GENERAL ELECTRIC	2320779	212519	-44	-84	6.58E-05	-9
P85	RW-2	GENERAL ELECTRIC	2320988	212468	-44	-84	6.58E-05	-9
P86	RW-3	GENERAL ELECTRIC	2323116	212183	-45	-85	0.014997	-2005
P87	RW-4	GENERAL ELECTRIC	2324547	211731	-43	-83	0.030575	-4087
P88	WW-1A	GENERAL ELECTRIC	2322457	210758	-40	-80	0.001025	-137
P89	WW-2	GENERAL ELECTRIC	2325572	210273	-42	-87	0.011	-1470
P90	WW-3	GENERAL ELECTRIC	2326061	209453	-38	-83	0.005901	-789
P91	WW-4A	GENERAL ELECTRIC	2324738	210884	-46	-86	0.018022	-2409
P92	WW-6	GENERAL ELECTRIC	2321237	211053	-42	-82	0.001479	-198
P93	WW-7A	GENERAL ELECTRIC	2326046	209727	-41	-71	0.005885	-787
P94	WW-8A	GENERAL ELECTRIC	2323329	211592	-45	-85	0.027616	-3692
P95	WW-9A	GENERAL ELECTRIC	2323117	212104	-44	-84	0.012252	-1638
P97	WW-11	GENERAL ELECTRIC	2321382	213233	-45	-85	0.031671	-4234
P98	WW-12	GENERAL ELECTRIC	2320983	213011	-44	-84	0.052712	-7047
P99	WW-13	GENERAL ELECTRIC	2320307	213029	-43	-83	0.021655	-2895
P100	WW-14	GENERAL ELECTRIC	2319972	213025	-42	-82	1.64E-05	-2
P102	WW-16	GENERAL ELECTRIC	2321755	212980	-43	-83	0.04183	-5592
P103	WW-17	GENERAL ELECTRIC	2322357	212412	-43	-83	0.018526	-2477
P104	WW-18	GENERAL ELECTRIC	2323471	212023	-53	-93	0.002992	-400
P105	WW-19	GENERAL ELECTRIC	2322662	212501	-43	-83	0.009896	-1323
P106	Dye #2	LANDFALL ASSOCIATES	2358761	176563	-118	-148	0.109479	-14635

Well Map ID	Well Name	OWNER	X Coordinate (NC State Plane, ft)	Y Coordinate (NC State Plane, ft)	Elevation of Top of Screen (ft MSL)	Elevation of Bottom of Screen (ft MSL)	Average Daily Pumping (MGD)	Average Daily Pumping (ft^3/day)
P107	Nicklaus	LANDFALL ASSOCIATES	2362309	182992	-109	-139	0.088027	-11768
P108	Pines	LANDFALL ASSOCIATES	2360429	180774	-109	-139	0.110685	-14796
P112	1	TOWN OF CAROLINA BEACH	2333216	104316	-114	-187	0.055767	-7455
P113	10	TOWN OF CAROLINA BEACH	2333168	112653	-139	-179	0.101	-13502
P114	11	TOWN OF CAROLINA BEACH	2333347	109076	-131	-171	0.046	-6149
P115	12	TOWN OF CAROLINA BEACH	2330911	100402	-98	-148	0.030647	-4097
P116	13	TOWN OF CAROLINA BEACH	2329968	101497	-100	-150	0.02203	-2945
P117	14	TOWN OF CAROLINA BEACH	2330405	98624	-99	-149	0.108474	-14501
P118	2	TOWN OF CAROLINA BEACH	2334733	103051	-123	-183	0.085	-11363
P119	3	TOWN OF CAROLINA BEACH	2336722	113978	-128	-138	0.066449	-8883
P121	5	TOWN OF CAROLINA BEACH	2334345	106365	-86	-135	0.023915	-3197
P122	6	TOWN OF CAROLINA BEACH	2332077	104459	-120	-150	0.042597	-5694
P123	7	TOWN OF CAROLINA BEACH	2330784	103278	-111	-122	0.105416	-14092
P124	8	TOWN OF CAROLINA BEACH	2334390	105504	-126	-151	0.07777	-10396
P125	9	TOWN OF CAROLINA BEACH	2332866	109609	-135	-175	0.041655	-5568
P134	I Avenue / #3	TOWN OF KURE BEACH	2330766	91270	-138	-158	0.029	-3877
P135	Kure Beach Village / #2	TOWN OF KURE BEACH	2331170	97522	-138	-158	0.112	-14972
P137	Ocean Dunes / #5	TOWN OF KURE BEACH	2328982	84041	-142	-162	0.085	-11363
P138	Seventh Ave. / #4	TOWN OF KURE BEACH	2329953	91987	-132	-152	0.141	-18849
P139	1	TOWN OF WRIGHTSVILLE BEACH	2370584	191474	-161	-177	0.086071	-11506
P140	2	TOWN OF WRIGHTSVILLE BEACH	2367968	176059	-152	-174	0.20629	-27577
P141	3	TOWN OF WRIGHTSVILLE BEACH	2364718	170113	-156	-193	0.073189	-9784
P142	4	TOWN OF WRIGHTSVILLE BEACH	2363154	167502	-150	-180	0.036767	-4915
P143	5	TOWN OF WRIGHTSVILLE BEACH	2361676	170935	-137	-149	0.051288	-6856
P144	6	TOWN OF WRIGHTSVILLE BEACH	2358748	171556	-138	-160	0.088767	-11866
P145	7	TOWN OF WRIGHTSVILLE BEACH	2359917	172246	-136	-158	0.051288	-6856
P146	8	TOWN OF WRIGHTSVILLE BEACH	2363543	172411	-138	-163	0.094685	-12658
P147	11	TOWN OF WRIGHTSVILLE BEACH	2355529	173761	-123	-160	0.064274	-8592

Appendix II: Monitoring Wells

Well Map ID	Well Name	X Coordinate (NC State Plane, ft)	Y Coordinate (NC State Plane, ft)	Elevation of Top of Screen (ft MSL)	Elevation of Bottom of Screen (ft MSL)	Average Observed Head in 2017 (ft MSL)	Computed Head (ft MSL)	Residual Head (ft)	Aquifer
M1	CLEMMONS TRAIL	2231232	111509	-8	-108	36.00	34.36	1.64	UPDA
M2	TOWN CREEK - AVG	2252502	154555	7.5	-16.5	20.16	19.28	0.88	UPDA
M3	MACO	2254743	197356	39	29	44.42	42.77	1.65	UPDA
M4	BOLIVIA FF33D2	2259013	118090	-52	-100	31.50	32.59	-1.09	UPDA
M5	BR-WELL15A	2274312	85064	-50	-104	15.29	13.10	2.19	UPDA
M6	BSRS2 - FF-32Y1	2277908	97525	-15.34	-98.34	45.49	44.28	1.22	UPDA
M7	BSRS2 - FF-32Y2	2277908	97525	43.72	38.72	45.37	44.46	0.91	SA
M8	SPRS5 GG32U3	2298715	67417	10.85	0.85	15.59	17.15	-1.56	SA
M9	SPRS2 GG32K5	2299683	74020	-57.1	-163.8	-14.76	-11.91	-2.85	UPDA
M10	SPRS2 GG32K7	2299683	74020	16.22	6.22	17.88	21.31	-3.43	SA
M11	SPRS4 GG32T5	2300390	71385	-35.74	-45.74	1.80	2.03	-0.23	CHA
M12	SPRS4 GG32T6	2300372	71376	17	7	22.80	22.19	0.61	SA
M13	SP-SAMW	2307693	73456	18.72	3.72	12.40	10.67	1.73	SA
M14	SP-CHAMW	2307707	73469	-35.95	-65.95	1.67	0.77	0.90	CHA
M15	SP-PDAMW	2307719	73485	-105.74	-125.74	-5.32	-6.88	1.55	UPDA
M16	FS-SAMW	2317112	171743	-1.26	-6.26	1.99	2.43	-0.45	SA
M17	FS-FLAMW	2317140	171747	-21.1	-31.1	2.32	2.47	-0.16	SA (FLUVIAL)
M18	FS-PDAMW	2317164	171750	-54.29	-66.29	2.25	2.23	0.02	UPDA
M19	FF-PDAMW	2321825	78724	-135.56	-150.56	0.60	0.06	0.54	UPDA
M20	FF-SAMW	2321844	78703	-0.13	-10.13	2.81	0.29	2.52	SA
M21	FF-CHAMW	2321857	78689	-40.65	-60.65	1.37	0.29	1.08	CHA
M22	PRESIDIO EE30P1	2327945	133965	-232	-252	0.77	2.79	-2.02	LPDA
M23	PRESIDIO EE30P3	2327945	133965	-137	-147	1.58	1.96	-0.38	UPDA
M24	NORTHERN REGIONAL PARK CC30E2	2331734	213149	-220	-240	15.32	10.89	4.43	LPDA
M25	NORTHERN REGIONAL PARK CC30E3	2331734	213149	-71	-81	18.06	19.59	-1.53	UPDA
M26	MYRTLE GROVE EE30M2	2341454	137738	-244	-264	0.20	2.42	-2.22	LPDA
M27	MYRTLE GROVE EE30M3	2341454	137738	-154	-164	0.15	2.63	-2.48	UPDA
M28	EAGLE POINT CC29L2	2372188	198733	-343	-363	-1.33	2.03	-3.36	LPDA
M29	EAGLE POINT CC29L4	2372188	198733	-136	-146	-0.63	4.74	-5.37	UPDA
M30	EAGLE POINT CC29L1	2372188	198733	-63	-73	3.15	4.88	-1.73	CHA
M31	H2GO 01P	2292925	170604	-291	-367	14.58	15.09	-0.51	LPDA
M32	PRESIDIO EE30P2	2327946	133964	-1.201	-11.201	14.85	12.90	1.95	SA
M33	MYRTLE GROVE EE30M1	2341453	137740	5.278	-21.722	2.33	1.87	0.46	SA
M34	NEW HANOVER CORR INST CC31U1	2325544	189194	22.02	7	14.11	10.58	3.53	SA