CHARLESTON HARBOR CURRENT SURVEY RECONNAISSANCE 2023 DATA REPORT

Silver Spring, Maryland
August 2024

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

Center for Operational Oceanographic Products and Services
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

The National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) provides the National infrastructure, science, and technical expertise to collect and distribute observations and predictions of water levels and currents to ensure safe, efficient and environmentally sound maritime commerce. The Center provides the set of water level and tidal current products required to support NOS' Strategic Plan mission requirements, and to assist in providing operational oceanographic data/products required by NOAA's other Strategic Plan themes. For example, CO-OPS provides data and products required by the National Weather Service to meet its flood and tsunami warning responsibilities. The Center manages the National Water Level Observation Network (NWLON), a national network of Physical Oceanographic Real-Time Systems (PORTS®) in major U. S. harbors, and the National Current Observation Program consisting of current surveys in near shore and coastal areas utilizing bottom mounted platforms, subsurface buoys, horizontal sensors and quick response real time buoys. The Center: establishes standards for the collection and processing of water level and current data; collects and documents user requirements, which serve as the foundation for all resulting program activities; designs new and/or improved oceanographic observing systems; designs software to improve CO-OPS' data processing capabilities; maintains and operates oceanographic observing systems; performs operational data analysis/quality control; and produces/disseminates oceanographic products.

NOAA CHARLESTON HARBOR CURRENT SURVEY RECONNAISSANCE 2023 DATA REPORT

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August 2024

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EXECUTIVE SUMMARY

The goal of NOAA's National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) National Current Observation Program (NCOP) is to collect tidal current information in order to maintain and update the tidal current predictions available online (https://tidesandcurrents.noaa.gov/), the primary motivation of which is to help ensure safe navigation as part of CO-OPS's mission. NCOP completes current surveys along the U.S. coastal and estuarine environments collecting current data by temporarily deploying acoustic doppler current profilers (ADCPs) at each site. Tidal constituents resulting from the data analysis at each station are used to generate the tidal predictions. In addition to supporting the navigational community, the data are also used to both help validate models and to complete circulation analyses by the academic and research community, and other interested stakeholders and partners.

Prior to the current survey, a field reconnaissance is completed in order to determine the feasibility of deploying and recovering ADCPs during the survey as well as the engineering and equipment requirements at each site. NOAA CO-OPS completed a field reconnaissance of the Charleston Harbor and surrounding rivers and inlets from October 8-18, 2023. During this time, environmental data were collected from a small NOAA research vessel (R/V *Tornado*, a 25' Parker) at each potential current survey station in order to determine site-specific characteristics. This includes collecting vertical conductivity, temperature, and depth (CTD) profiles, sediment bottom samples, depth soundings, vessel set and drift, and observations noting vessel traffic and other significant landmarks at each reconnaissance station.

This report summarizes the data collection completed by NCOP in the 2023 Charleston Harbor reconnaissance, including the first operational deployments of both OSKER surface drifters (3) and the Nortek vessel-mounted (VM) ADCP system. The surface drifters were deployed in the Ashley, Cooper, and Wando rivers, and they transmitted position and surface current speed via XEOS Iridium for several days before being recovered. The Nortek VM system was used to collect ADCP transects both across and along the navigational channel at several locations (14) in order to better determine the spatial variability of the currents between reconnaissance stations.

All of the environmental information collected during the reconnaissance will be used to refine the upcoming Fiscal Year 2024 (FY24) NOAA Charleston Harbor Tidal Current Survey station list and guide the sensor and mount type requirements at each station. This data has been shared with modelers at NOAA and academic institutions in support of the ongoing NOAA Southeast Operational Forecast System (OFS) development and other external model validation.

All data described in this report is available to the public upon request (Tide.Predictions@noaa.gov).

1.0 INTRODUCTION

The data described in this report was collected in support of the National Currents Observation Program (NCOP), the primary motivation of which is to update the tidal current predictions in order to help ensure safe navigation as part of CO-OPS's mission. A NOAA Tidal Current Survey in Charleston Harbor and the surrounding rivers and inlets is planned for Fiscal Year 2024 (FY24). In 2014, Charleston Harbor ranked number 17 in priority for CO-OPS potential tidal survey locations using the Fuzzy Logic routine in Potential Location Assessment of Coastal & Estuarine Surveys (PLACES; Fanelli et al. 2014). This assessment took into account information such as the number of vessel accidents (2), average tidal current (0.6 m/s), commercial tonnage (17,986,000 short tons), cruise passengers (165,500), and the approximate year of the last survey (1987).

In preparation for the current survey, a NOAA field reconnaissance was conducted from October 8-18, 2023, on a small NOAA research vessel (R/V *Tornado*, a 25' Parker). The goal of the field reconnaissance was to collect environmental data at each potential current survey station location in order to determine the feasibility of and requirements for deploying and recovering equipment on site during the current survey. The final current survey station locations are selected based upon the reconnaissance data collected, the internal needs and capabilities of NOAA, as well as consultation with local partners and stakeholders, including professional mariners, federal agencies, academics, modelers, and researchers.

The reconnaissance station locations cover the entrance of Charleston Harbor and surrounding areas including the Ashley River, Cooper River, Wando River, Intracoastal Waterway (ICW), and several nearby coastal inlets (Table 1.1; Figures 1.1 and 1.2). Three stations south of Charleston Harbor cover the southern extent of the survey and include the Stono River Inlet entrance south of Folly Beach (CHR03), the North Edisto River Inlet entrance south of Seabrook Island (CHR02), and St. Helena's Sound and South Edisto River entrance (CHR01). These southern inlets were chosen in an effort to close the spatial gap between the upcoming Charleston current survey and the recently completed Fiscal Year 2023 (FY23) NCOP Savannah River Current Survey.

During the reconnaissance, environmental data were collected at each station location (45 total) including sediment bottom samples, vertical conductivity, temperature, and depth (CTD) casts, depth soundings, and observations such as vessel traffic and significant landmarks. In addition to the data collected at each stationary location, surface GPS drifters (3) were deployed, and vessel-mounted acoustic doppler current profilers (ADCPs) transects (14) were completed for the first time operationally in order to better understand the spatial variability of currents between reconnaissance sites.

The data collected during the reconnaissance described in this report will be used to refine the upcoming (FY24) current survey station list and determine the equipment and vessel requirements for the current survey. The data were shared with modelers in order to support the model development efforts for the NOAA Southeast Atlantic and extramural systems developed and maintained at Virginia Institute of Marine Science (VIMS) and North Carolina State University.

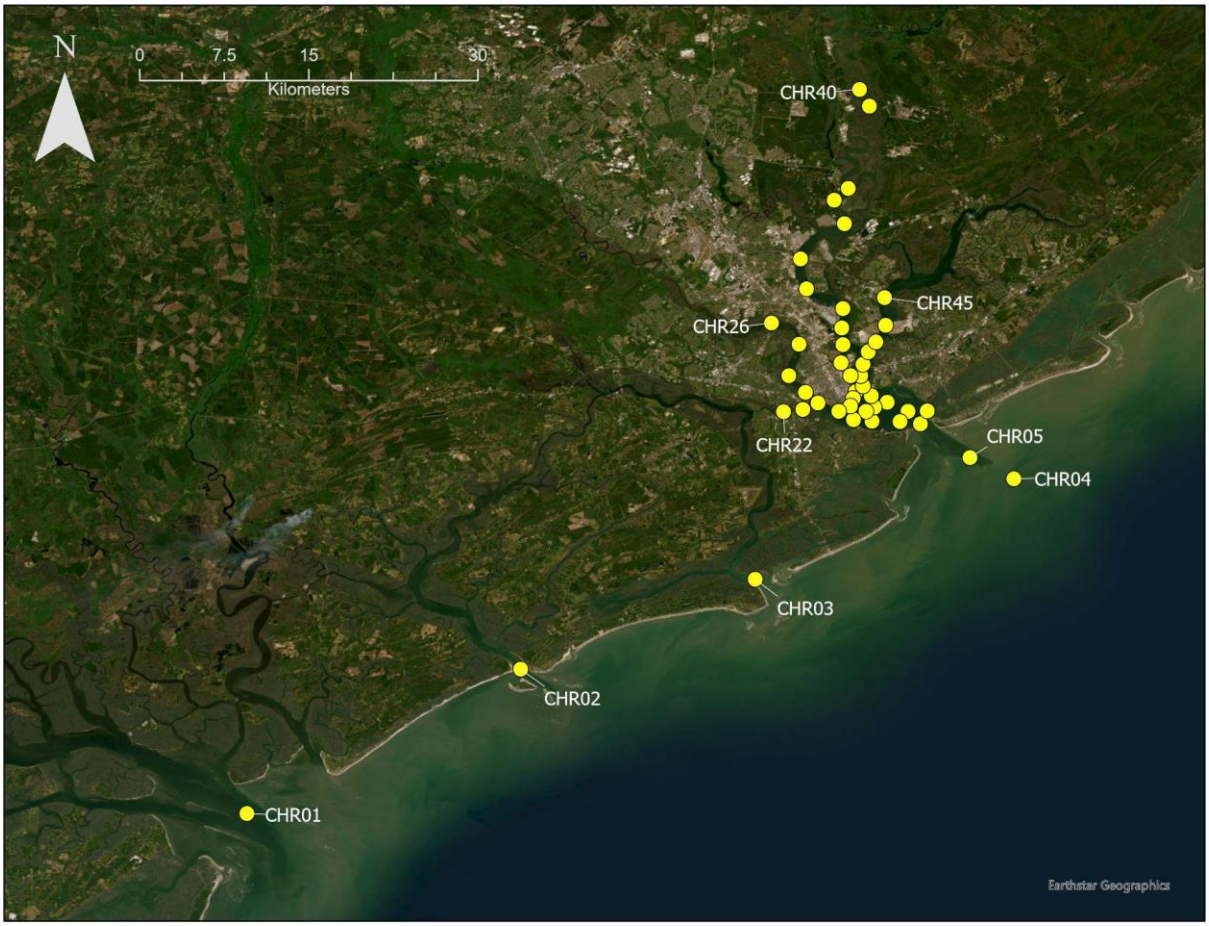

Figure 1. The station locations (45 total) occupied during the 2023 NOAA Charleston Harbor Reconnaissance. Several stations are labeled with their respective station ID as listed in Table 1.1.

Figure 2. The station locations within Charleston Harbor, Ashley River (CHR23-CHR26), Cooper River (CHR30-CHR40), Wando River (CHR41-CHR45), and the Intracoastal Waterway (CHR07, CHR21, and CHR22) occupied during the 2023 NOAA Charleston Harbor Reconnaissance. Stations are labeled with their respective Station ID as listed in Table 1.1.

Table 1. NOAA Charleston Harbor Current Survey Reconnaissance station IDs, positions, water depth (measured from the vessel fathometer), and date and time (UTC) of vessel arrival on station.

Station ID	Latitude	Longitude	Area	Depth (Fathometer, m)	Date Occupied (UTC)
CHR01	32.4470	-80.4050	St. Helena Sound Entrance	12.5	10/18/2023 15:05
CHR02	32.5617	-80.1867	North Edisto River Entrance	14.7	10/16/2023 15:33
CHR03	32.6333	-80.0000	Stono River Entrance	9	10/16/2023 16:35
CHR04	32.7130	-79.7940	Charleston Harbor Entrance	9.5	10/10/2023 13:20
CHR05	32.7300	-79.8290	Charleston Harbor Entrance	15	10/10/2023 13:03
CHR06	32.7567	-79.8683	Charleston Harbor Entrance	13	10/10/2023 12:45
CHR07	32.7670	-79.8630	Intracoastal Waterway Northern Entrance	5	10/10/2023 13:55
CHR08	32.7667	-79.8783	Charleston Harbor, Northern channel	17	10/10/2023 14:27
CHR09	32.7587	-79.8847	Charleston Harbor, Southern channel	7.4	10/10/2023 14:40
CHR10	32.7590	-79.9070	Charleston Harbor, Southern channel	7.7	10/10/2023 14:58
CHR11	32.7740	-79.8950	Charleston Harbor, Northern channel	5	10/09/2023 17:15
CHR12	32.7700	-79.9050	Charleston Harbor, Middle Ground	5.5	10/09/2023 17:35
CHR13	32.7667	-79.9117	Charleston Harbor, Middle Ground	7.5	10/09/2023 17:48
CHR14	32.7602	-79.9216	Charleston Harbor, Southern channel	4.5	10/10/2023 15:09
CHR15	32.7791	-79.9074	Charleston Harbor, Northern channel	15.2	10/09/2023 17:00
CHR16	32.7825	-79.9200	Charleston Harbor, Battery	9	10/09/2023 18:23
CHR17	32.7770	-79.9221	Charleston Harbor, Battery	8	10/09/2023 18:14
CHR18	32.7710	-79.9240	Charleston Harbor, Battery	2	10/09/2023 17:58

Station ID	Latitude	Longitude	Area	Depth (Fathometer, m)	Date Occupied (UTC)
CHR19	32.7667	-79.9333	Ashley River Entrance, SW Battery	7	10/12/2023 19:17
CHR20	32.7733	-79.9500	Ashley River & Wappoo Creek Entrance	7	10/09/2023 16:34
CHR21	32.7683	-79.9620	Wappoo Creek	8.8	10/17/2023 15:25
CHR22	32.7665	-79.9775	Wappoo Creek	10.2	10/17/2023 15:50
CHR23	32.7817	-79.9600	Ashley River	8.2	10/12/2023 19:52
CHR24	32.7950	-79.9733	Ashley River	11.3	10/12/2023 18:45
CHR25	32.8200	-79.9650	Ashley River	7.8	10/12/2023 18:25
CHR26	32.8370	-79.9870	Ashley River	6.5	10/12/2023 17:56
CHR27	32.7870	-79.9140	Cooper/Wando River Entrances	11	10/09/2023 18:31
CHR28	32.7950	-79.9160	Cooper/Wando River Entrances	12.5	10/09/2023 18:45
CHR29	32.7950	-79.9240	Cooper/Wando River Entrances	12.4	10/09/2023 18:59
CHR30	32.8053	-79.9317	Cooper/Wando River Entrances	15.5	10/13/2023 16:32
CHR31	32.8199	-79.9300	Cooper River Entrance	10	10/13/2023 16:17
CHR32	32.8330	-79.9310	Cooper River	13	10/13/2023 16:00
CHR33	32.8483	-79.9300	Cooper River	14.4	10/13/2023 15:44
CHR34	32.8640	-79.9590	Cooper River	16.3	10/13/2023 15:33
CHR35	32.8880	-79.9640	Cooper River	14	10/13/2023 15:26
CHR36	32.9160	-79.9290	Cooper River	11.2	10/13/2023 15:11
CHR37	32.9346	-79.9370	Cooper River	13	10/13/2023 15:01
CHR38	32.9440	-79.9260	Cooper River	14.7	10/13/2023 14:45
CHR39	33.0093	-79.9091	Cooper River	11.9	10/13/2023 13:33
CHR40	33.0227	-79.9169	Cooper River	10.7	10/13/2023 14:10

Station ID	Latitude	Longitude	Area	Depth (Fathometer, m)	Date Occupied (UTC)
CHR41	32.8040	-79.9140	Cooper/Wando River Entrances	12	10/14/2023 16:08
CHR42	32.8140	-79.9100	Wando River Entrance	9	10/14/2023 16:00
CHR43	32.8220	-79.9040	Wando River	15	10/14/2023 15:48
CHR44	32.8350	-79.8960	Wando River	17	10/14/2023 15:36
CHR45	32.8570	-79.8969	Wando River	11.9	10/14/2023 15:10

2.0 METHODS

All on-water operations were conducted using NOAA-owned research R/V *Tornado* (Figure 2.1), a 7.6-meter (m) (25-feet [ft]) style boat manufactured by Parker that has lifting capability up to 135 kilograms (kg).

Figure 3. The NOAA research vessel (R/V) *Tornado* (25' Parker) equipped with a davit used for operations in the Charleston Harbor Reconnaissance.

2.1 Reconnaissance Stations

At each station (45 total; Figures 1.1 and 1.2; Table 1.1), the water depth from the vessel's fathometer was recorded, a CTD vertical profile was taken using a YSI CastAway® - CTD to ascertain physical properties of the seawater at each station, and a bottom sediment sample was collected using a Van Veen grab. All station metadata, including the vessel set and drift and observations regarding vessel traffic and significant landmarks were recorded on station log sheets.

2.2 Surface Drifters

Three OSKER GPS surface drifters were initially deployed in the Ashley (D1), Cooper (D2), and Wando Rivers (D3) on October 12, 2023, at 18:08 UTC; October 13, 2023, at 12:58 UTC; and October 14, 2023, at 15:31 UTC, respectively (Figure 2.2; Table 2.1). In order to avoid the drifter getting caught in seagrass or other obstructions (e.g., piers) and potentially impairing the ability to be recovered, 2 of the drifters (D1 and D2) were intermittently recovered and redeployed at nearby locations farther out into the channel (Table 2.1). The OSKER drifters transmit position and surface current speed via XEOS Iridium every 10 minutes. Once D2 had drifted out of Charleston Harbor into the ocean, the drifter transmission rate was changed to record

GPS position and speed every 30 minutes and transmit those messages every 2 hours. The dates and times of the final recoveries are listed in Table 2.1.

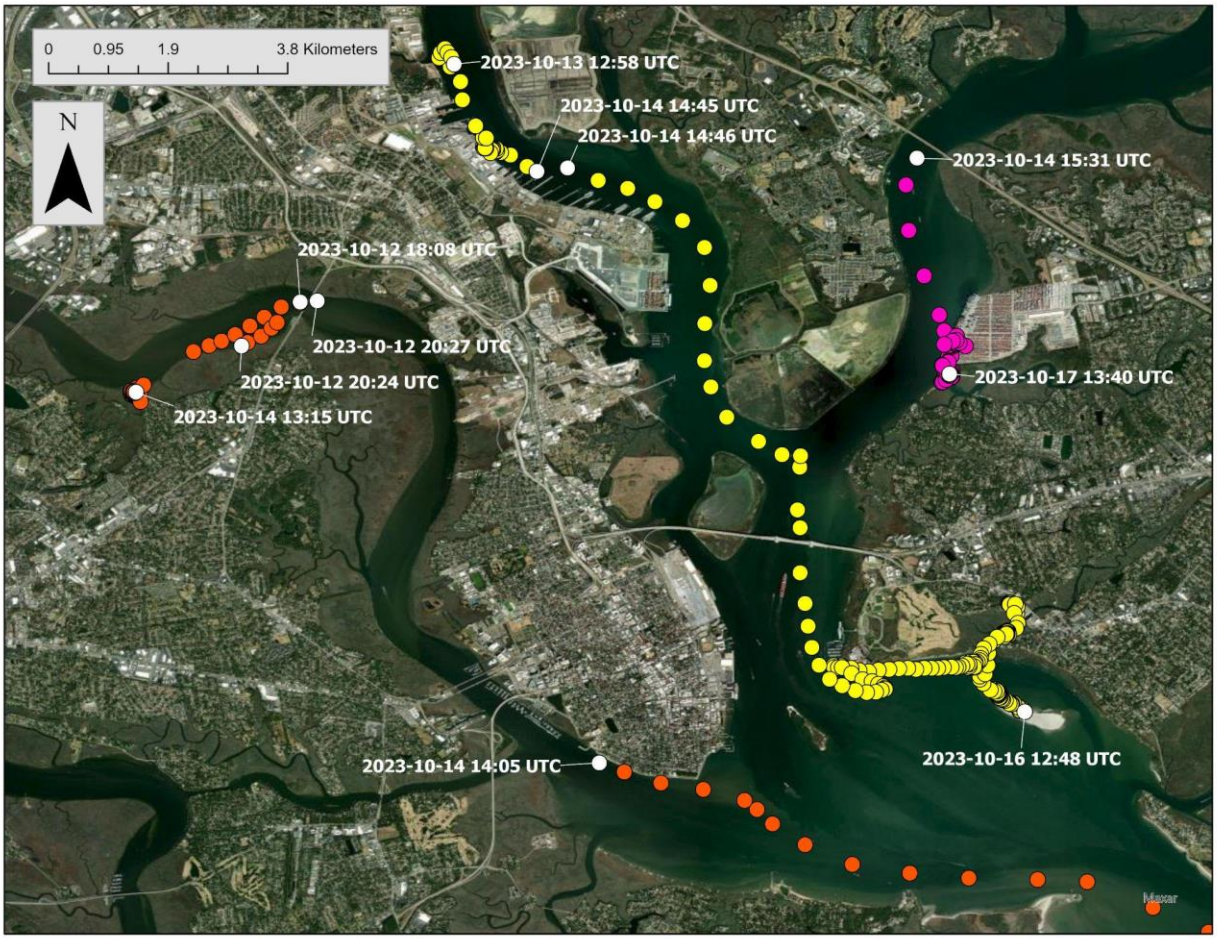

Figure 4. The GPS positions from the 3 surface GPS drifters in the Ashley River (orange, D1), Cooper River (yellow, D2), and Wando River (magenta, D3). The entire D2 track is not shown here and instead can be seen in the Results section below. The white dots indicate the approximate deployment and recovery positions with times (UTC) labeled as listed in Table 2.1.

Table 2. Metadata pertaining to the deployment and recovery of the 3 surface drifters in the Ashley River (D1), Cooper River (D2), and Wando River (D3). The final recovery of D1 (asterisk) is approximate as it was found washed ashore by a civilian. The positions listed here are associated with those transmitted nearest in time to the time logged (listed in second column).

Drifter ID	Date (UTC)	Latitude	Longitude	Action
D1	10/12/2023 18:08	32.83731	-79.98562	Initial Deployment
D1	10/12/2023 20:24	32.83101	-79.99397	First Recovery
D1	10/12/2023 20:27	32.83744	-79.98319	Second Deployment
D1	10/14/2023 13:15	32.82441	-80.00907	Second Recovery
D1	10/14/2023 14:05	32.77157	-79.9289	Third Deployment
D1	10/15/2023 15:15	N/A	N/A	Changed GPS & XEOS transmission rate
D1	10/18/2023 16:10 *	29.99255	-81.31577	Final Recovery (washed ashore)
D2	10/13/2023 12:58	32.87122	-79.963629	Initial Deployment
D2	10/14/2023 14:45	32.85591	-79.951782	First Recovery
D2	10/14/2023 14:46	32.85644	-79.94740	Second Deployment
D2	10/14/2023 12:48	32.77887	-79.88211	Final Recovery
D3	10/14/2023 15:31	32.85782	-79.89749	Initial Deployment
D3	10/17/2023 13:40	32.82705	-79.89287	Final Recovery

2.3 ADCP Transects

The data along 14 transect lines (Figure 2.3) was collected using the Nortek vessel-mounted (VM) system, which consists of a downward-facing Signature500 (500 kHz) with bottom tracking capability, an external GNSS antenna mounted in line with ADCP, and a Nortek computer used to collect and process the data. The ADCP and GNSS antenna were mounted onto the NOAA R/V *Tornado* (25' Parker) midships on the starboard gunnel.

For all transects, the cell size was set to 0.5 m with a blanking distance of 0.5 m, and the total number of cells was 139 (Table 2.2). Data were sampled at a rate of 1 Hz, quality controlled using parameters listed in Table 2.2, and averaged every 10 seconds (s). Metadata and data processing parameters specific to the VM system configuration per transect are listed in Table 2.3. For cross-channel transects, data were collected for roughly a 20-minute total duration including all passes. For transects with only 1 pass (e.g., along-channel), data were collected over a shorter duration. The start time of each transect is listed in Table 2.3.

The quality controlled time series of Transect 1 (T1) is shown in Figure 2.4 and serves as an example of the data collected along all transects (T1-T14). The depth averaged mean velocity is calculated along each cross-channel transect after removing the data outside of the navigational channel and then averaging the data in space by clustering the data from the multiple passes along the transect into groups based on distance in the cross-channel direction (Figure 2.5). For along-channel transects (and others not oriented either along or across the channel), the depth averaged velocity is similarly averaged in space (and subsequently also in time) along the 1 pass completed without needing to remove data outside of the channel (Figure 2.6).

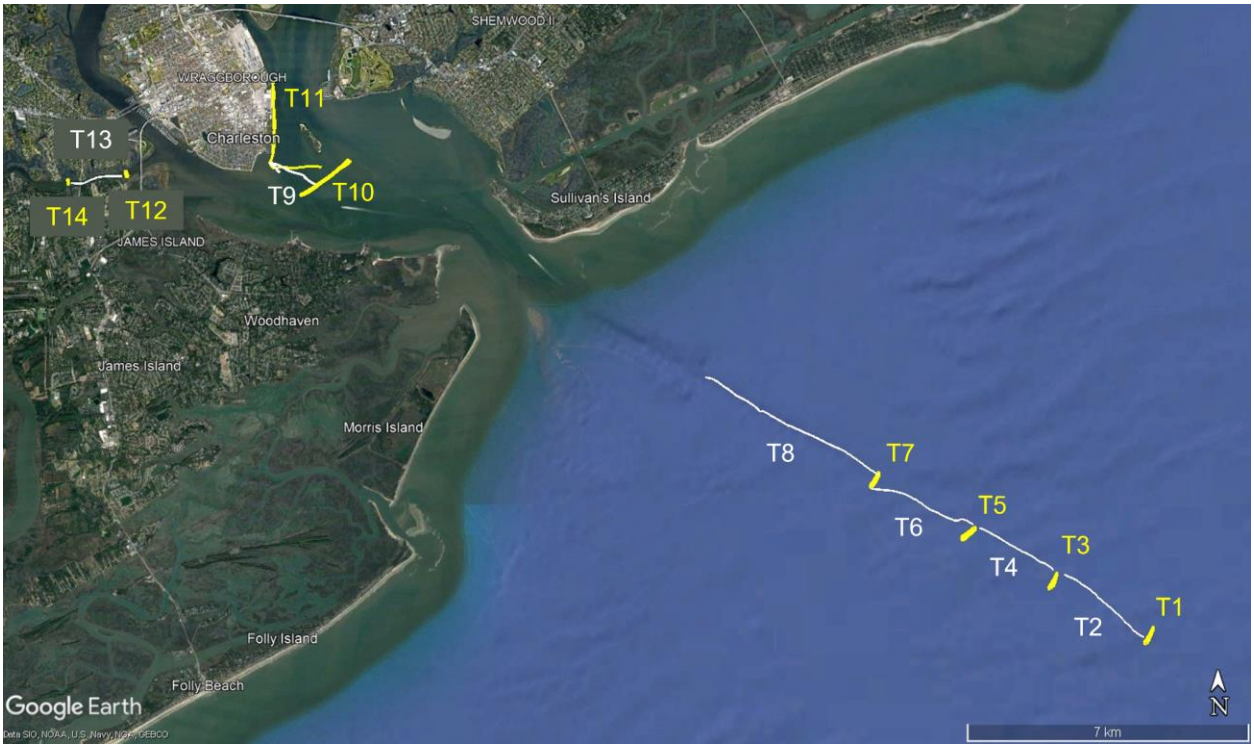

Figure 5. Nortek vessel-mounted (VM) system transect lines (T1-T14) outside and inside of Charleston Harbor and in Wappoo Creek. The white lines (T2, T4, T6, T8, T9, and T13) indicate 1 pass along the transect was completed. The yellow lines (T1, T3, T5, T7, T10, T11, T12, and T14) indicate transects along which multiple passes (4-17) were completed.

Table 3. Metadata and quality control parameters applicable to all acoustic doppler current profiler (ADCP) transects.

Parameter	Value
Bin Size	0.5 m
Blanking Distance	0.5 m
Total Number of Bins	139
ADCP Mounting Depth	0.5 m
ADCP Sample Rate	1 Hz
ADCP Frequency	500 kHz
GNSS Alignment (Z-direction)	1.2 m
Percentage of Water Column Excluded due to Sidelobe Interference	10% (near seafloor)
Correlation Minimum Threshold (within each cell)	50%
Amplitude Minimum Threshold (within each cell)	30 dB
Time Average	10 s

Table 4. Metadata and quality control parameters associated with the respective acoustic doppler current profilers (ADCP) transect lines. The date indicates the start time of the transect. The transect orientation indicates the direction of the vessel heading with respect to the navigational channel (i.e., cross-channel, along-channel, or neither listed as N/A). The ADCP orientation, GNSS orientation, and approximate salinity are parameters used in post-processing the data. The number of passes completed along each transect is listed in the far right column.

Transect Line	Date (UTC)	Transect Orientation	ADCP Orientation	GNSS Orientation	Salinity (PPT)	Number of Passes
1	10/11/2023 12:45	Cross	-51	-3	33	10
2	10/11/2023 13:07	Along	-50	-3	32	1
3	10/11/2023 13:22	Cross	-51	-3	32	10
4	10/11/2023 13:43	Along	-50	-3	30	1
5	10/11/2023 13:53	Cross	-51	-3	30	10
6	10/11/2023 14:16	Along	-50	-3	30	1
7	10/11/2023 14:30	Cross	-51	-3	30	11
8	10/11/2023 14:53	Along	-50	-3	30	1
9	10/11/2023 15:48	N/A	-50	-3	25	1
10	10/11/2023 15:56	N/A	-50	-3	25	4.5
11	10/11/2023 16:30	N/A	-51	-2	25	2
12	10/17/2023 14:56	Cross	-49	10	25	17.5
13	10/17/2023 15:23	Along	-52	12	25	1
14	10/17/2023 15:30	Cross	-51	12	25	>8

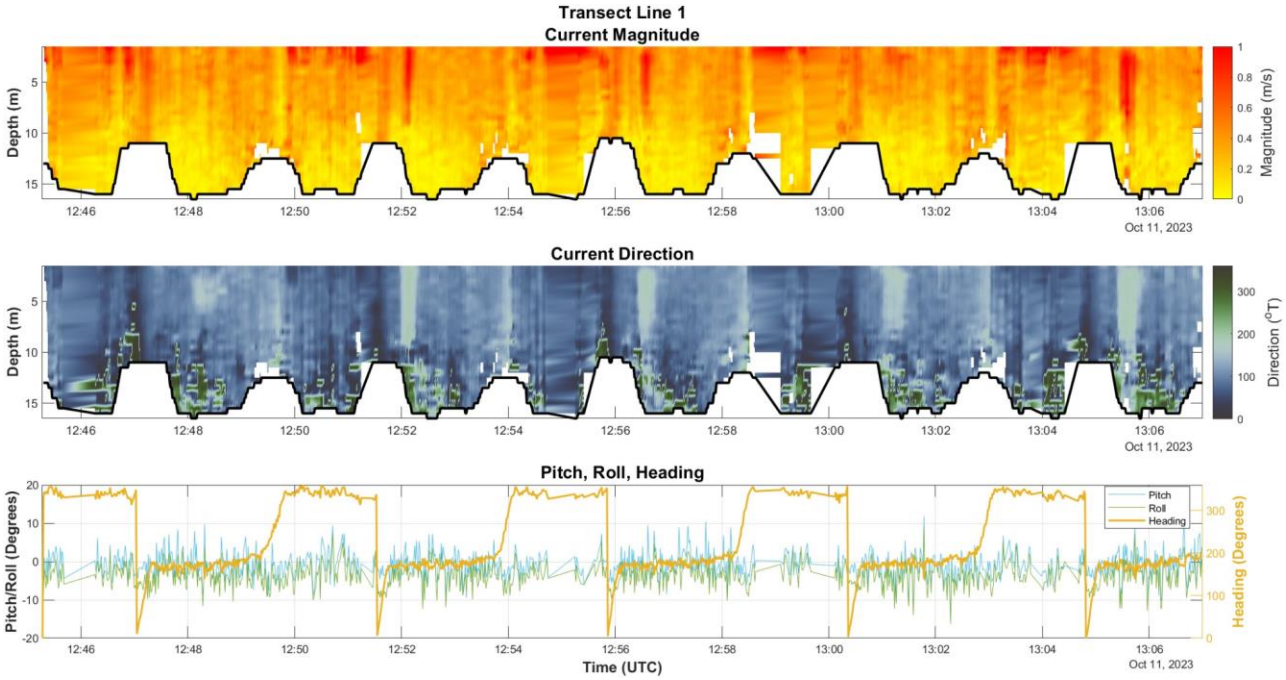

Figure 6. Quality controlled 10-second averaged data along transect line 1. Top: Current magnitude (m/s). Middle: Current direction (degrees). Bottom: pitch (blue), roll (green), and heading (yellow) over time (x-axis) and depth (y-axis for top and middle plots).

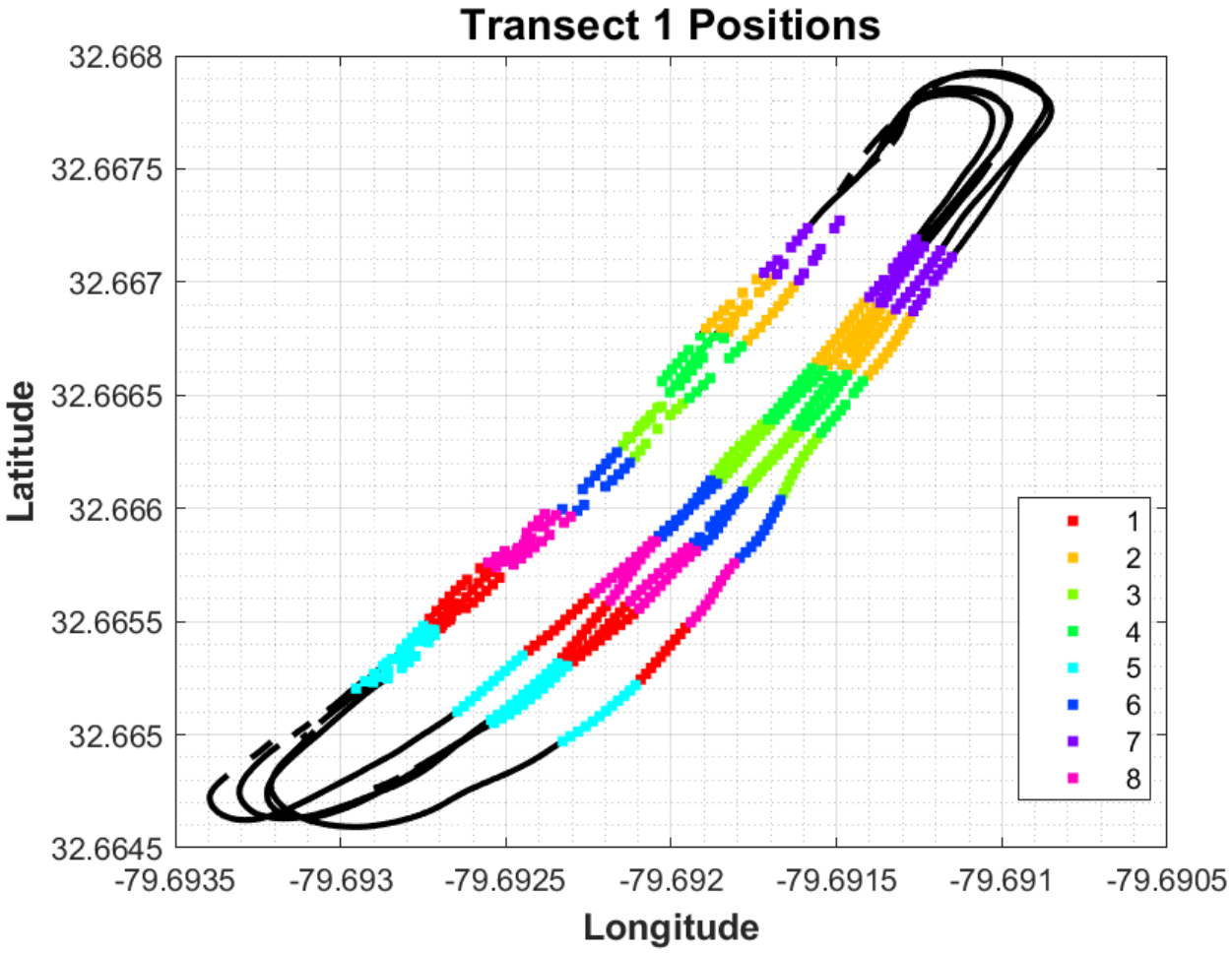

Figure 7. Transect 1 positions (latitude and longitude) clustered together by position (colors) while excluding the data outside of the channel (black lines) while the vessel was turning around. The colored clusters were then averaged together (after depth averaging) resulting in a mean velocity per cluster shown in the Results section below.

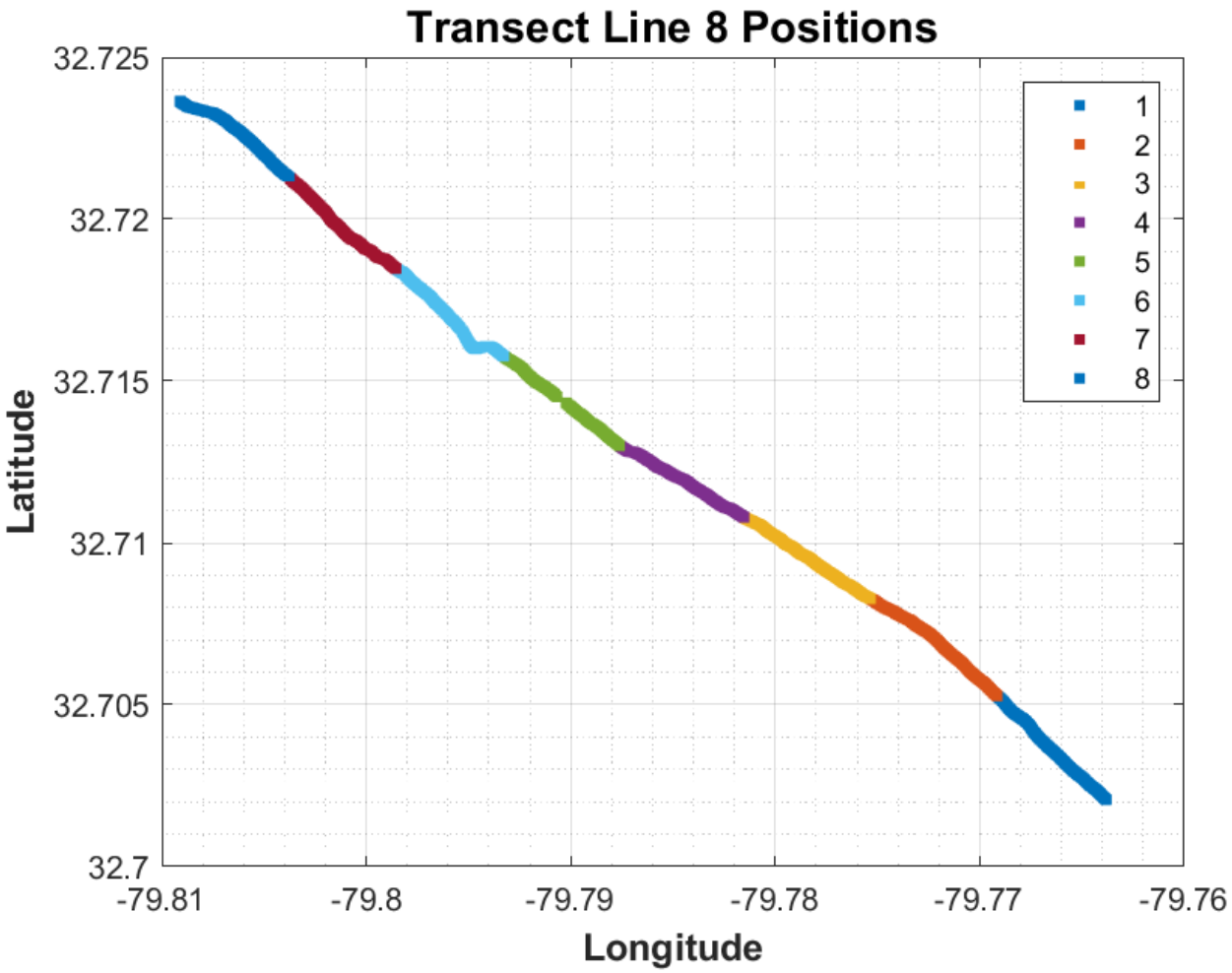

Figure 8. Transect 8 positions (latitude and longitude) clustered together by position (colors). The colored clusters were then averaged together (after depth averaging) resulting in a mean velocity per cluster shown in the Results section below.

3.0 RESULTS

3.1 CTD Casts

The water temperature, salinity, and density collected via CTD casts at several stations located near the Charleston Harbor entrance and the southern inlets are shown in Figure 3.1. These data are available for all stations, not just those shown in Figure 3.1. The depth averaged (i.e., mean) water temperature and salinity are shown at all stations in Figures 3.2 and 3.3, respectively. The spatial variability in the water properties is apparent between stations; however, it is important to note that the casts were collected on different days and times of day (spanning October 9-18, 2023; Table 1.1), so temporal variability is also a factor when comparing stations.

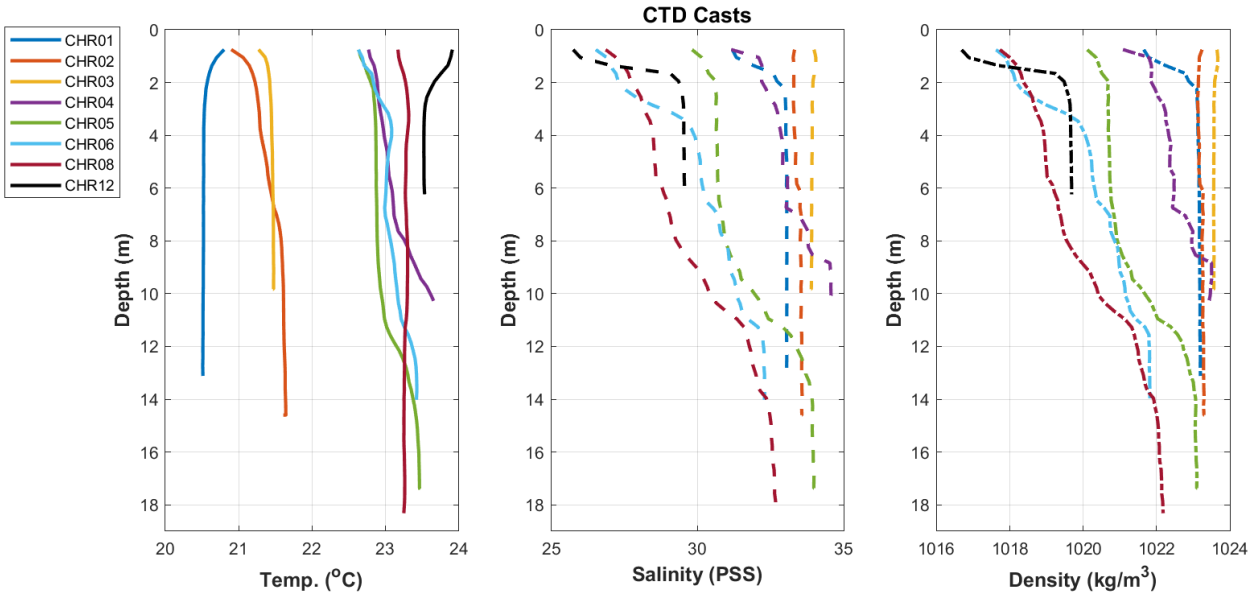

Figure 9. The water temperature (left plot), salinity (practice salinity scale [PSS]; middle plot), and density (right plot) over depth (y-axis) collected at CHR01 (blue), CHR02 (red), CHR03 (yellow), CHR04 (purple), CHR05 (green), CHR06 (light blue), CHR08 (maroon), and CHR12 (black). The raw downcast is shown here. The conductivity, temperature, and depth (CTD) casts at each of the stations were collected on different days at times similar to those listed in Table 1.1.

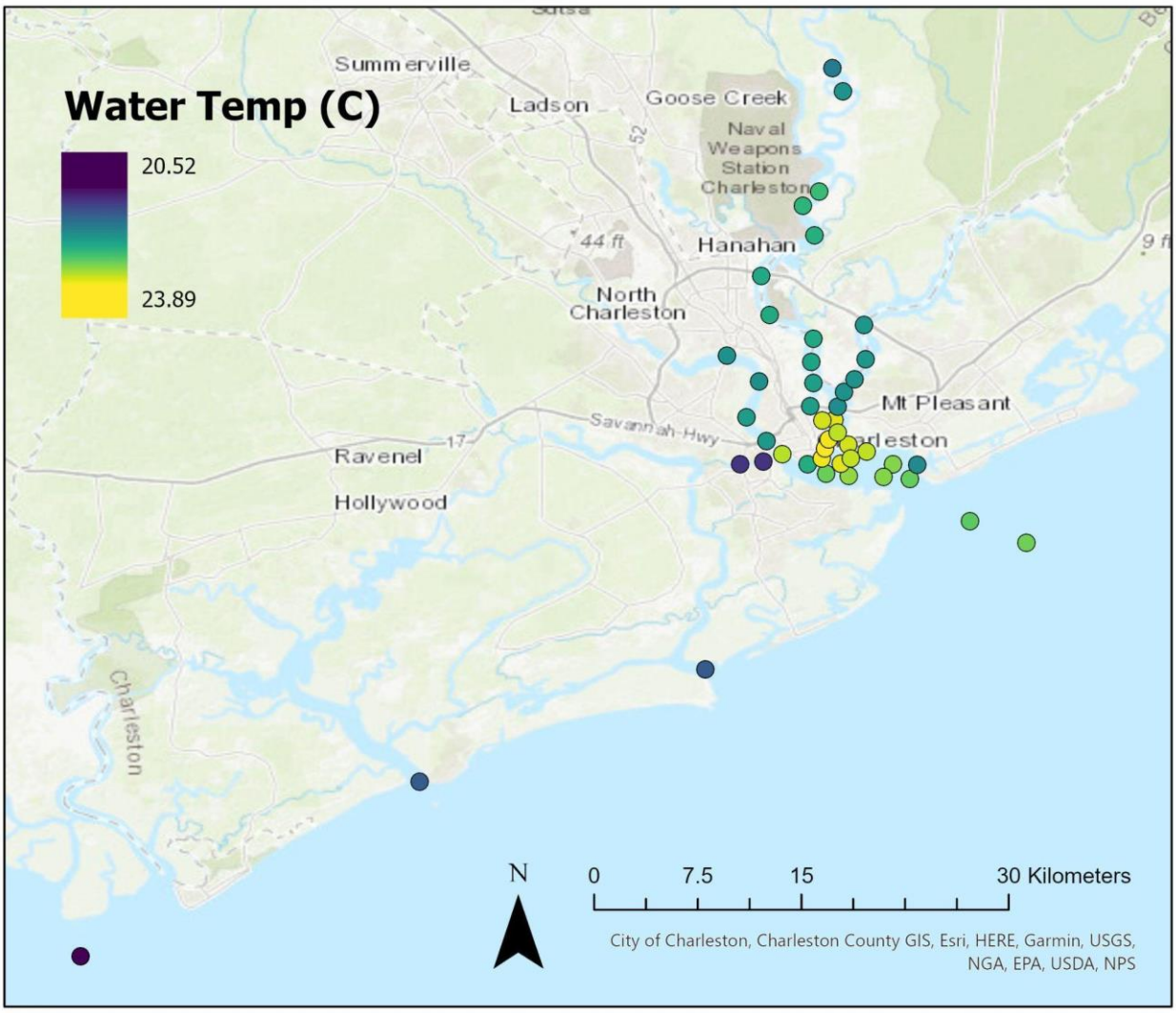

Figure 10. Mean water temperature (°C) collected at each station via conductivity, temperature, and depth (CTD) cast. The dates and approximate times of CTD collection at each site are listed in Table 1.1.

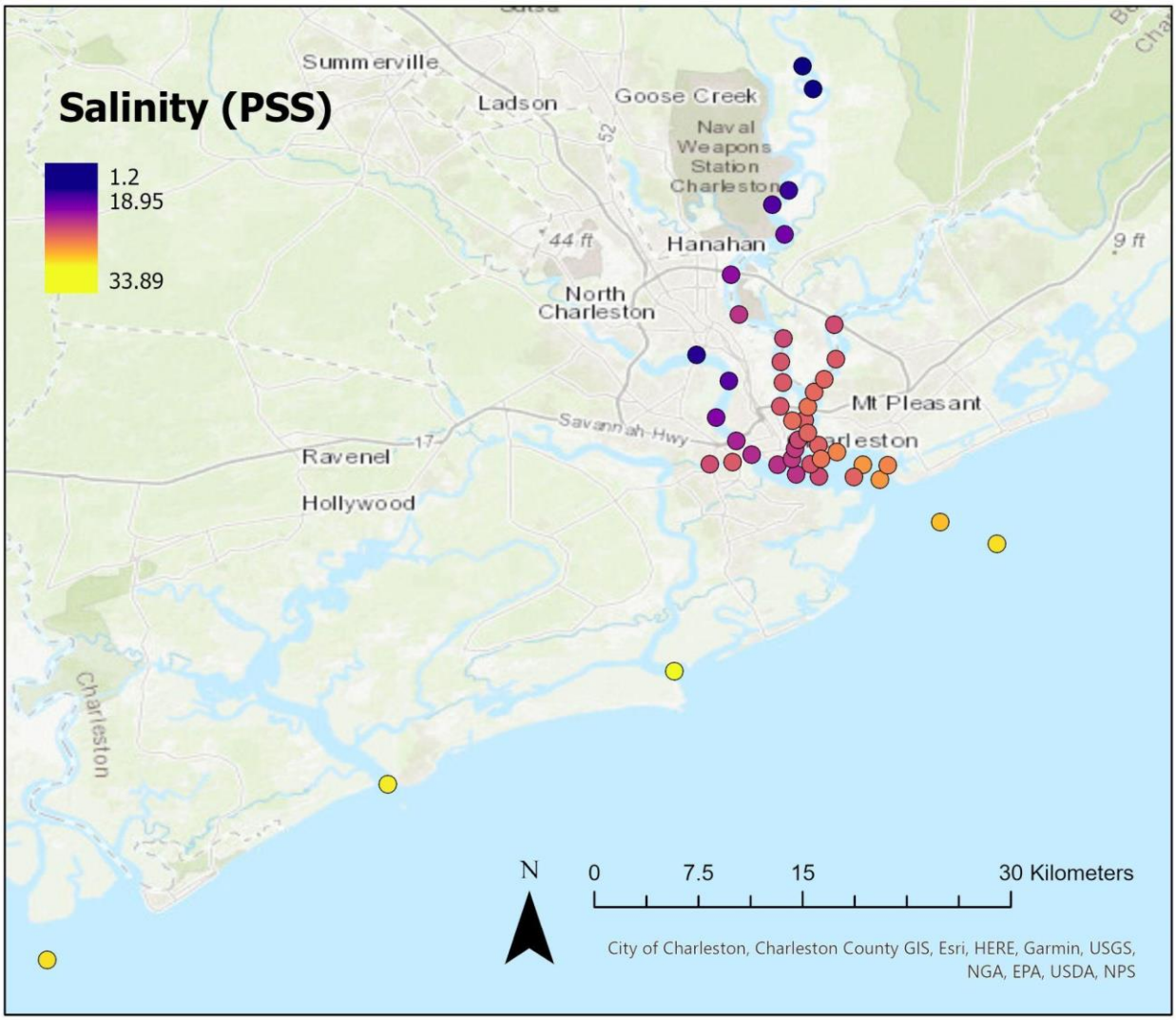

Figure 11. Mean salinity (practice salinity scale [PSS]) collected at each station. The dates and approximate times of conductivity, temperature, and depth (CTD) collection at each site are listed in Table 1.1.

3.2 Surface Drifters

The current speed (knot) transmitted by the 3 drifters (D1, D2, and D3) is shown in Figure 3.4. The full D1 GPS track from Charleston to Florida is shown in Figure 3.5. A full GPS track of D2 is shown in Figure 3.6 with a zoomed-in view from Patriots Point into Shem Creek before recovery in Mount Pleasant Channel is shown in Figure 3.7.

The Ashley River drifter (D1) was deployed on October 12, 2023, at 18:08 UTC and recovered shortly thereafter at 20:24 UTC from a shallow seagrass marsh upriver (north) from the Route 7 bridge and moved downriver (south) of the Route 7 bridge before re-deploying at 20:27 UTC. It was recovered again on October 14, 2023, at 13:15 UTC from a similar shallow seagrass marshy area upriver of the bridge and deployed farther downriver near the entrance of the Ashley River on the western side of Charleston on October 14, 2023, at 14:05 UTC. The drifter followed the ebb tide and drifted out of the harbor and into the ocean a few hours later. While following the surface ocean currents, the drifter washed ashore and was found by a civilian in South Ponte Vedra Beach, FL, on November 18, 2023, around 16:10 UTC.

The Cooper River drifter (D2) was deployed on October 13, 2023, at 12:58 UTC and initially recovered on October 14, 2023, at 14:45 in order to move it away from piers where large

vessels were docked. It was deployed 1 minute later nearby, farther out in the channel. The surface drifter then flowed down the Cooper River, around Patriots Point into Shem Creek, eventually back out into the Mount Pleasant Channel, and washed ashore the Crab Bank Seabird Sanctuary where it was recovered on October 16, 2023, at 12:48 UTC.

The Wando River drifter (D3) was deployed downriver of the Route 526 bridge on October 14, 2023, at 15:31 UTC and quickly moved into a shallow marshy area a few hours after deployment and was recovered in that general area on October 17, 2023, at 13:40 UTC.

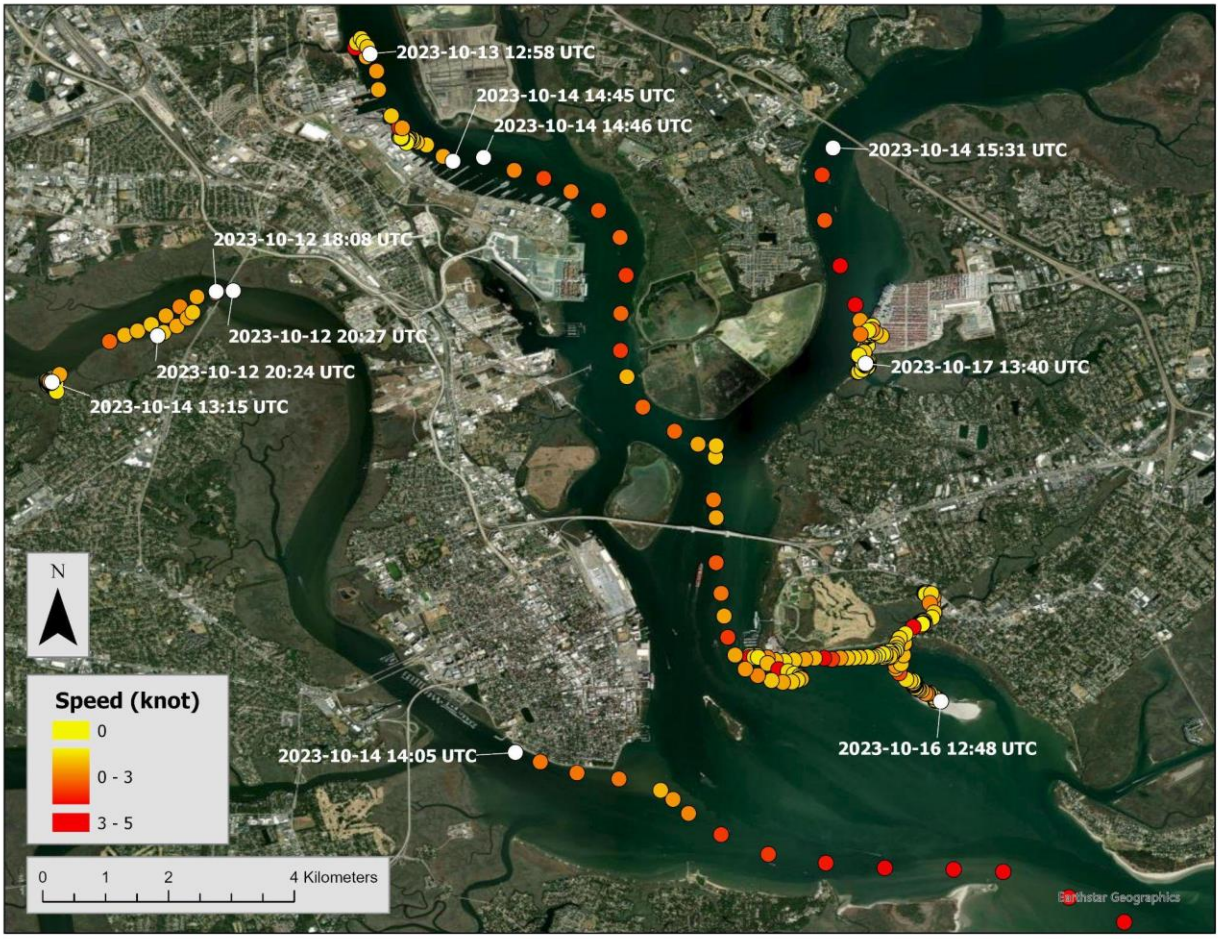

Figure 12. Current speed (knot) transmitted by the OSKER surface drifters in the Ashley River (D1), Cooper River (D2), and Wando River (D3). The white dots indicate the approximate deployment and recovery locations of the drifters as listed in Table 2.1.

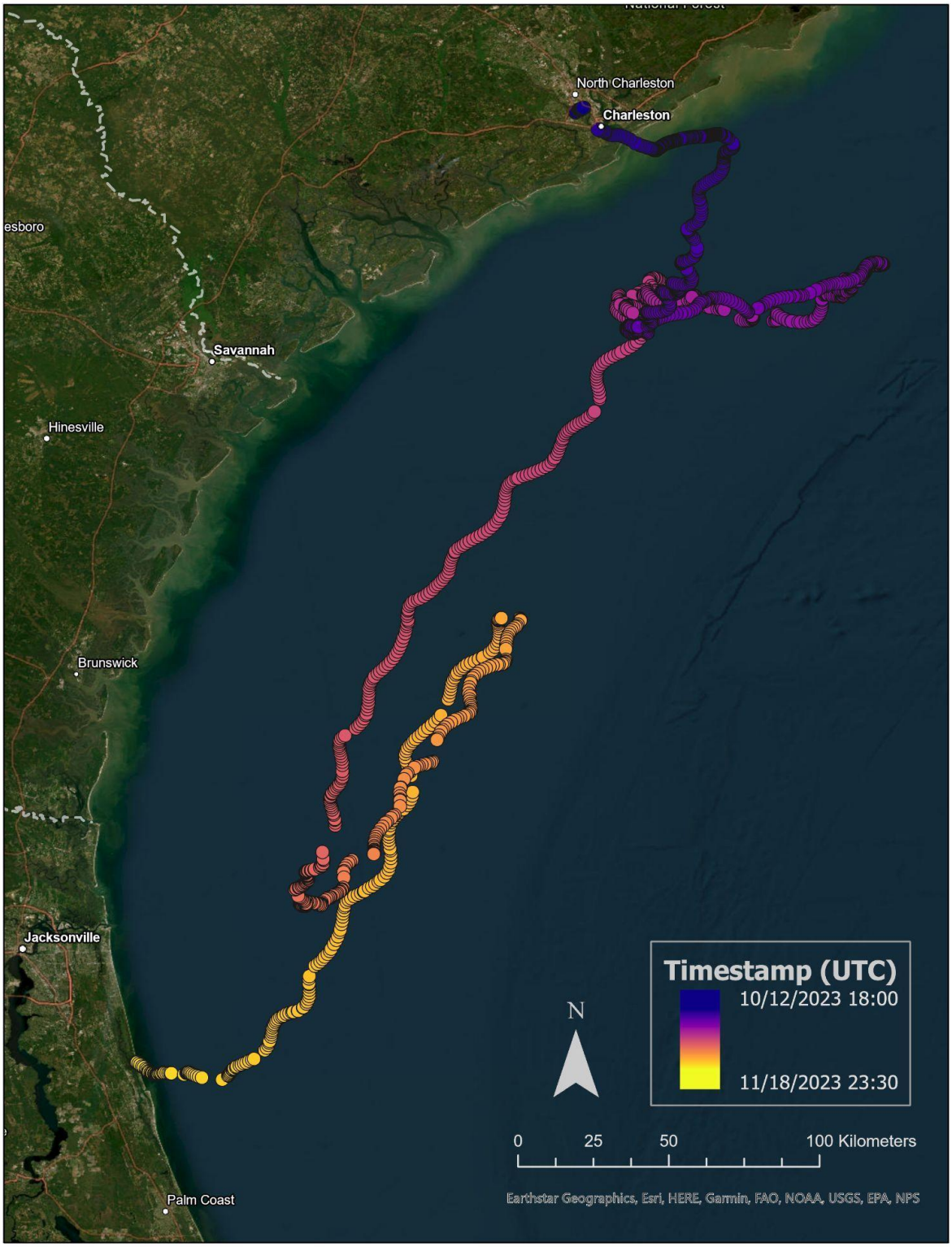

Figure 13. The GPS positions transmitted by the OSKER surface drifter over time initially deployed in the Ashley River (D1) on October 13, 2023. The drifter eventually washed ashore and was found in South Ponte Vedra Beach, FL, on November 18, 2023.

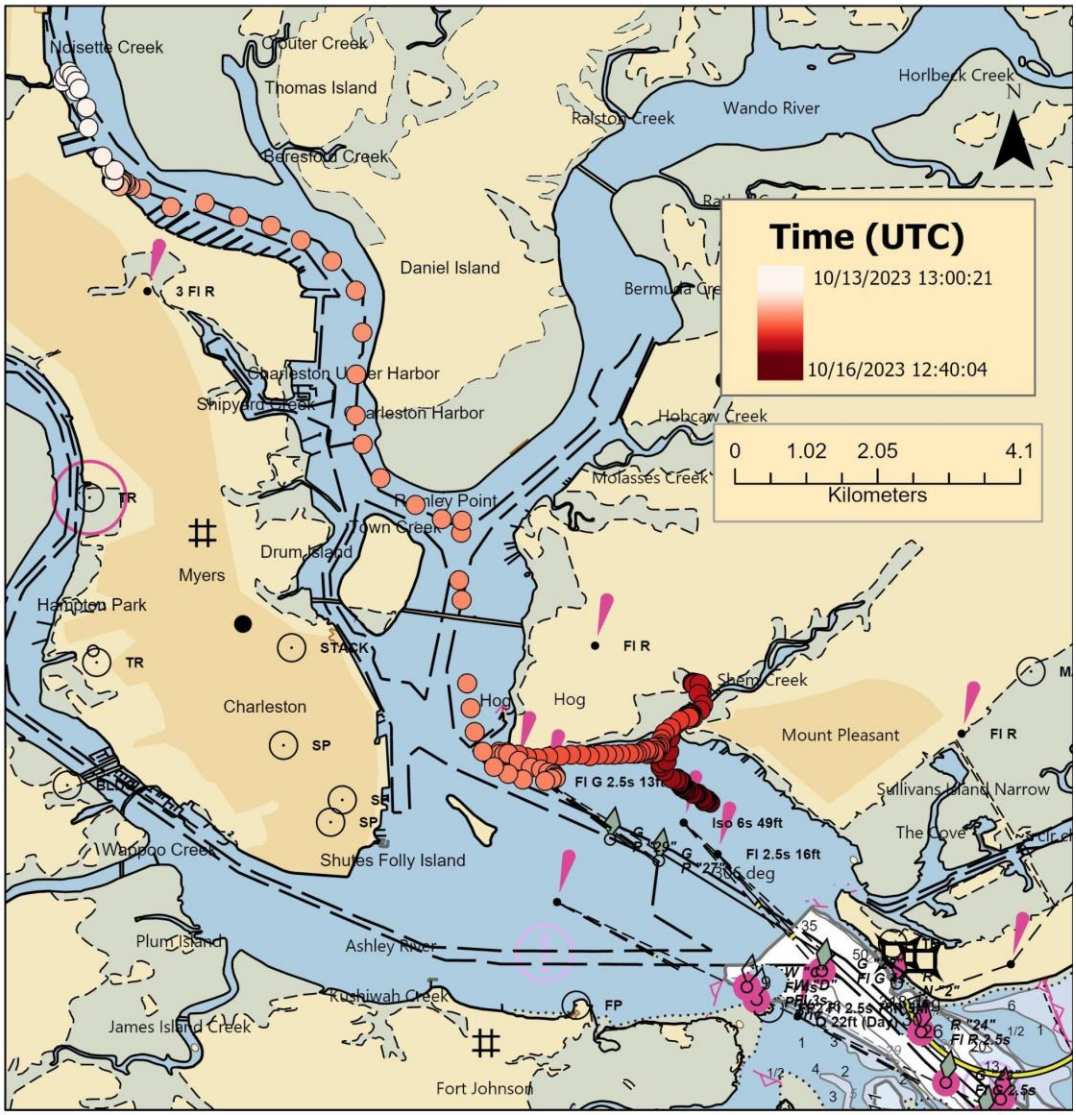

Figure 14. The GPS positions transmitted by the OSKER surface drifter over time initially deployed in the Cooper River (D2) on October 13, 2023. After passing Patriots Point, the drifter floated into Shem Creek before drifting back out into Mount Pleasant Channel prior to recovery on October 16, 2023.

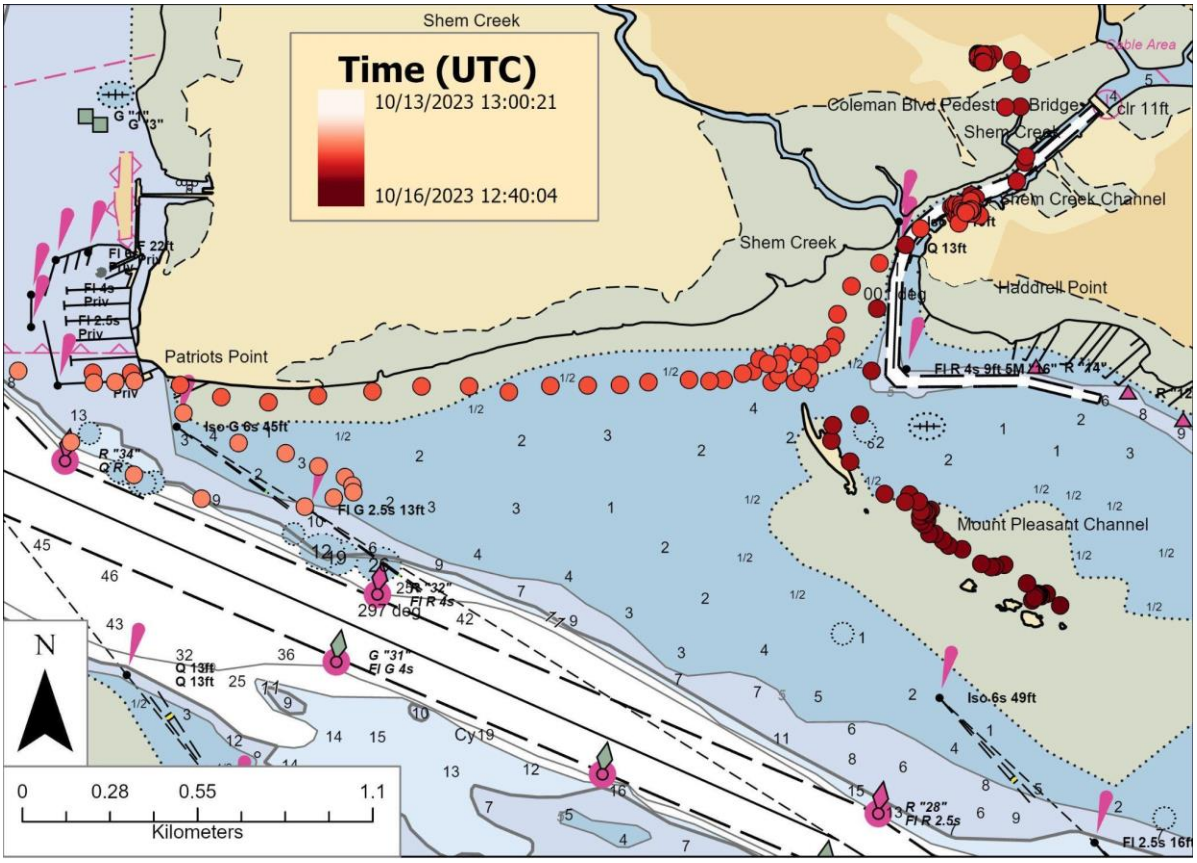

Figure 15. A zoomed-in view of the D2 path after passing Patriots Point drifting into Shem Creek and eventually drifting back out into Mount Pleasant Channel prior to recovery on October 16, 2023.

3.3 ADCP Transects

The mean (spatially and depth averaged) velocity is shown along each transect (T1-T14) in Figures 3.8-3.17, respectively. The vectors are scaled by the current magnitude and direction. All ADCP transects collected data during an ebb tide; the start time is listed in Table 2.3 and can be compared to nearby historic tidal current prediction stations (available online: https://tidesandcurrents.noaa.gov/).

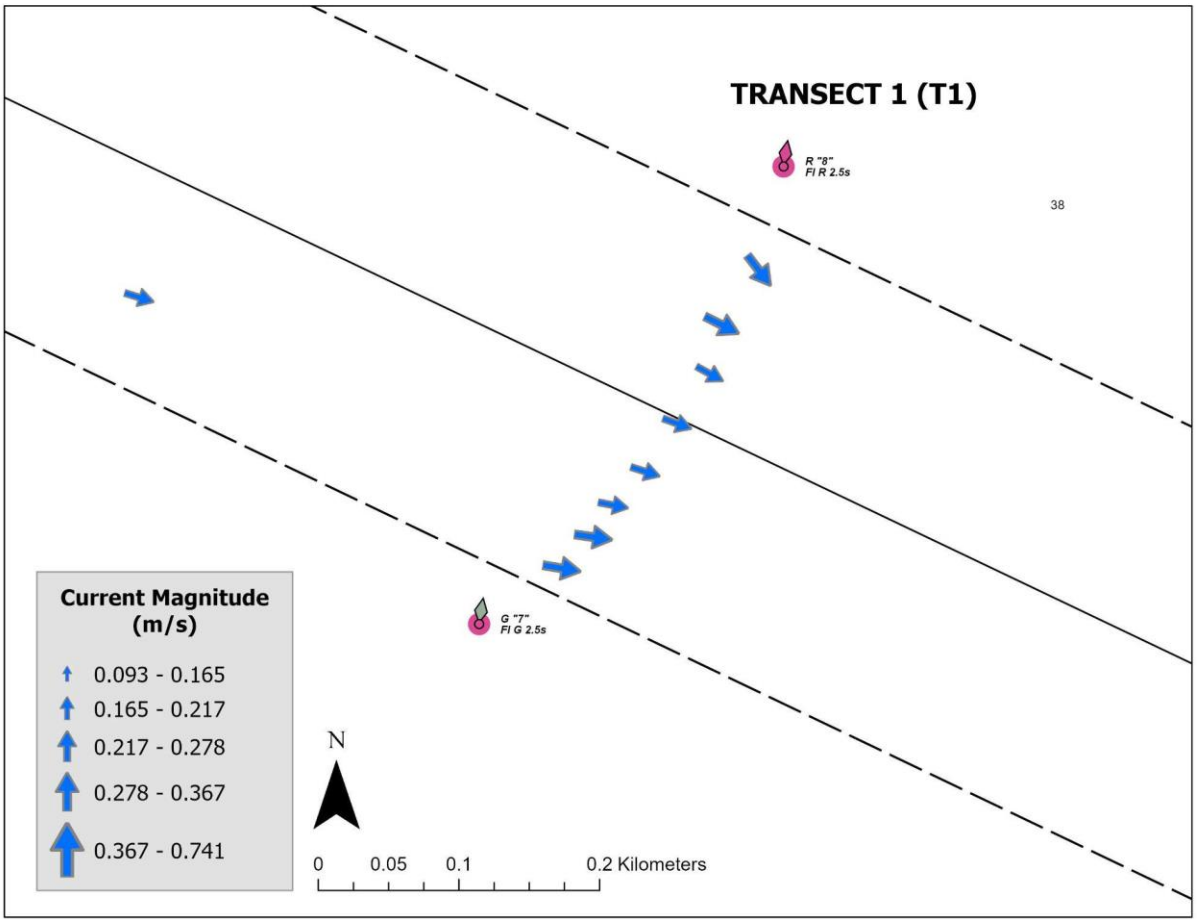

Figure 16. Depth-averaged mean velocity along Transect line 1 (T1) between aids to navigation (ATONs) 7 and 8. The blue vectors are scaled by the current magnitude and direction.

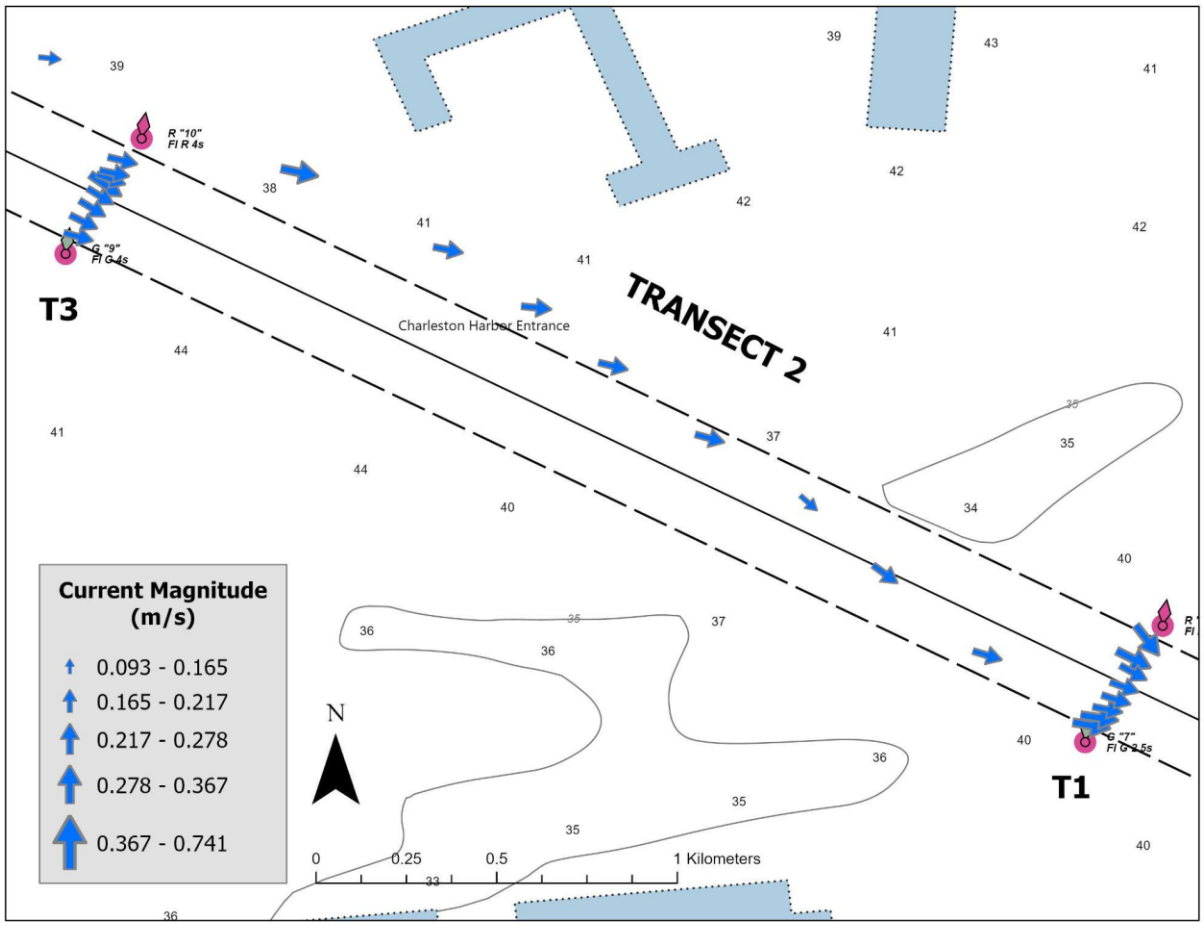

Figure 17. Depth-averaged mean velocity along Transect line 2 (T2) between aids to navigation (ATONs) 7 and 10. The blue vectors are scaled by the current magnitude and direction.

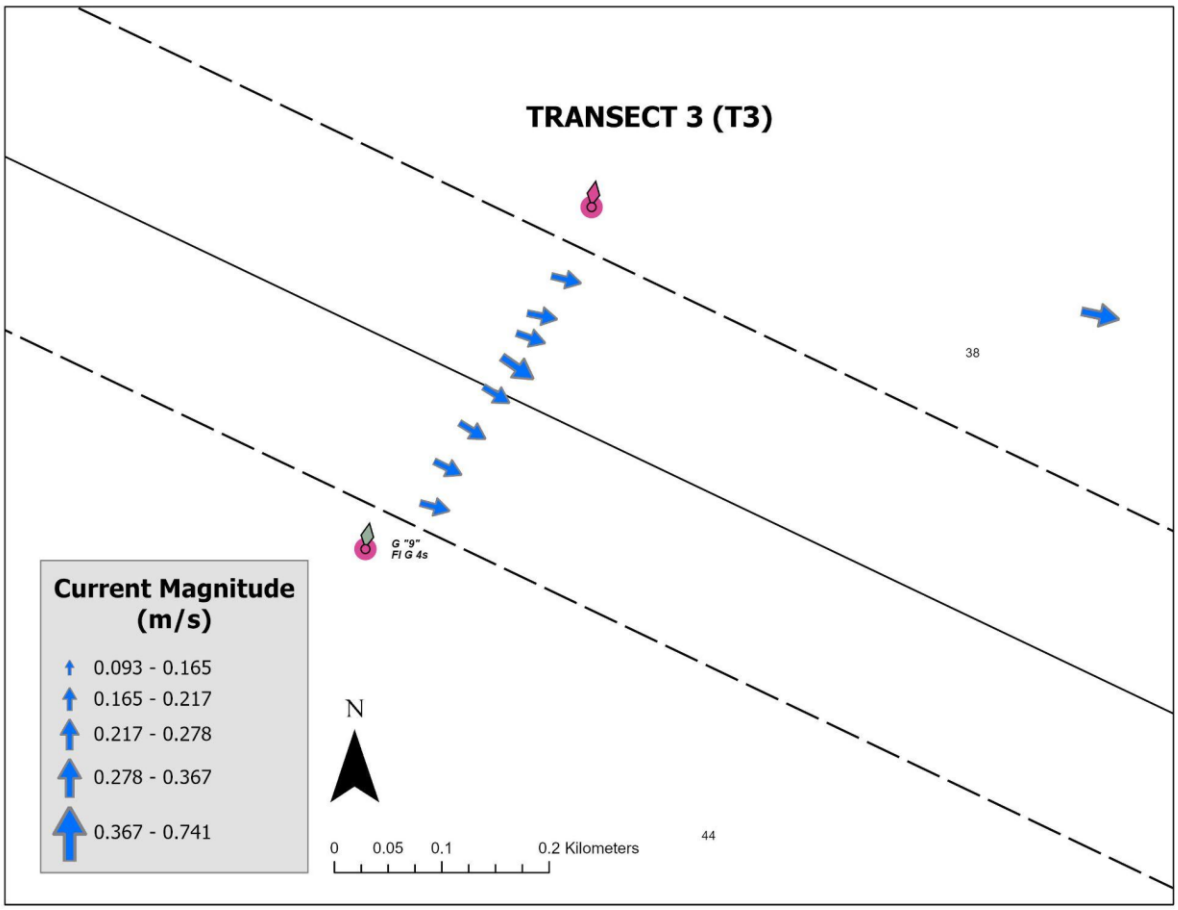

Figure 18. Depth-averaged mean velocity along Transect line 3 (T3) between aids to navigation (ATONs) 9 and 10. The blue vectors are scaled by the current magnitude and direction.

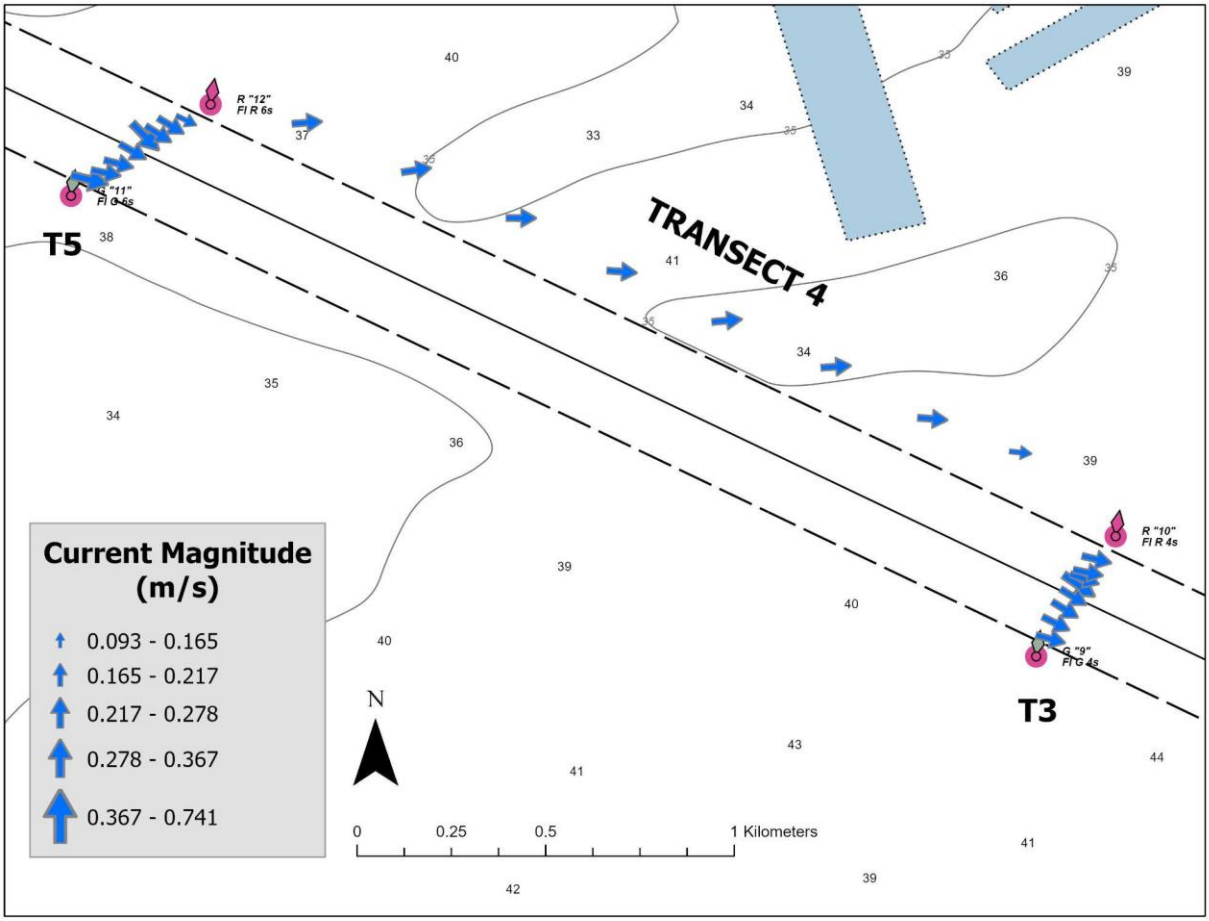

Figure 19. Depth-averaged mean velocity along Transect line 4 (T4) between aids to navigation (ATONs) 10 and 12. The blue vectors are scaled by the current magnitude and direction.

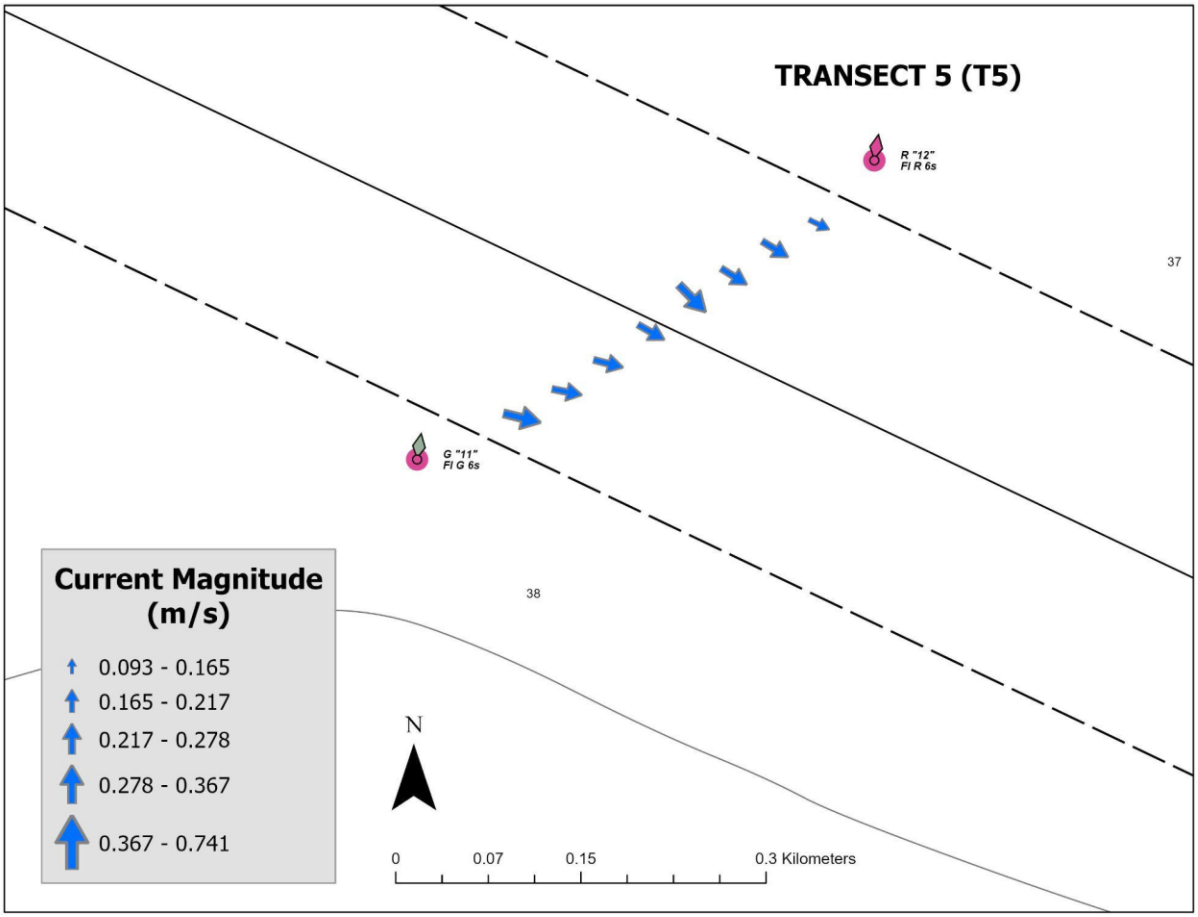

Figure 20. Depth-averaged mean velocity along Transect line 5 (T5) between aids to navigation (ATONs) 11 and 12. The blue vectors are scaled by the current magnitude and direction.

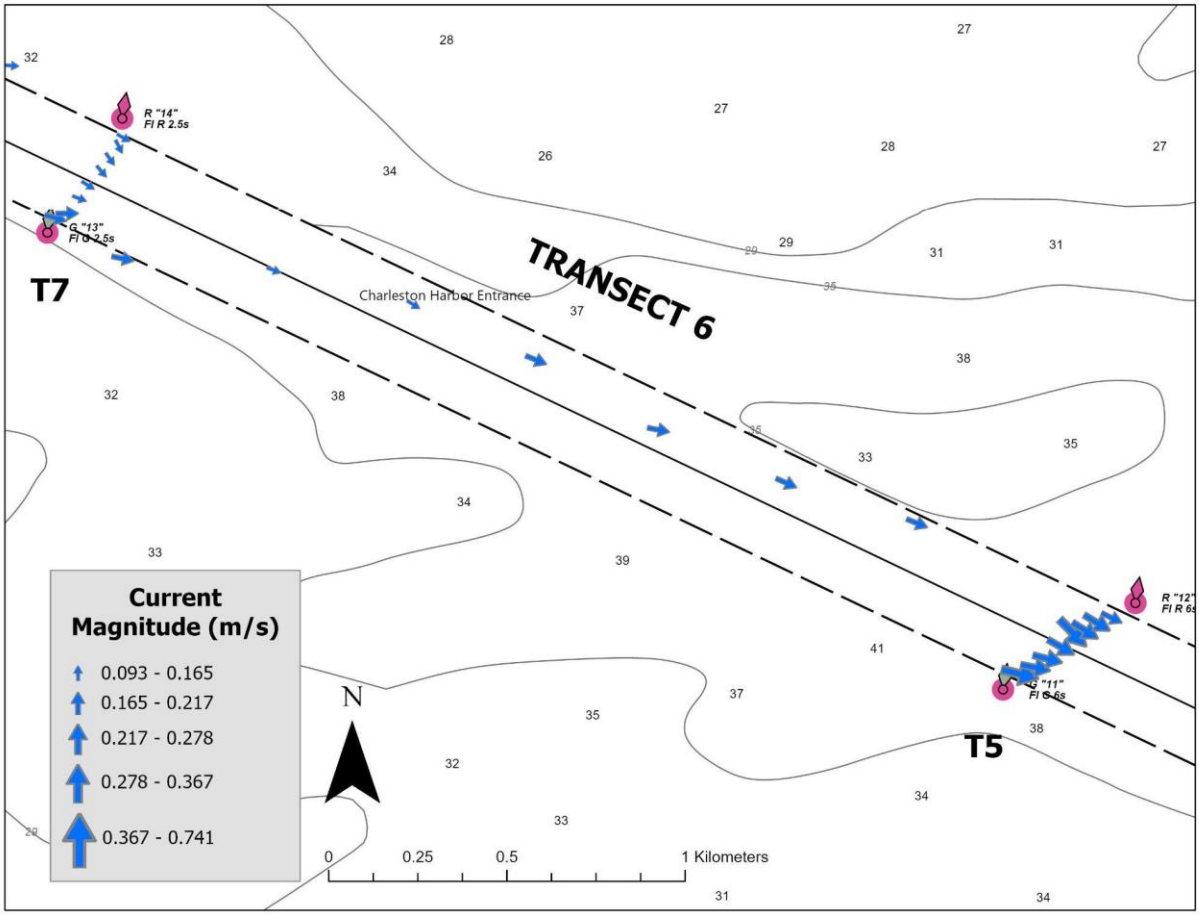

Figure 21. Depth-averaged mean velocity along Transect line 6 (T6) between aids to navigation (ATONs) 12 and 13. The blue vectors are scaled by the current magnitude and direction.

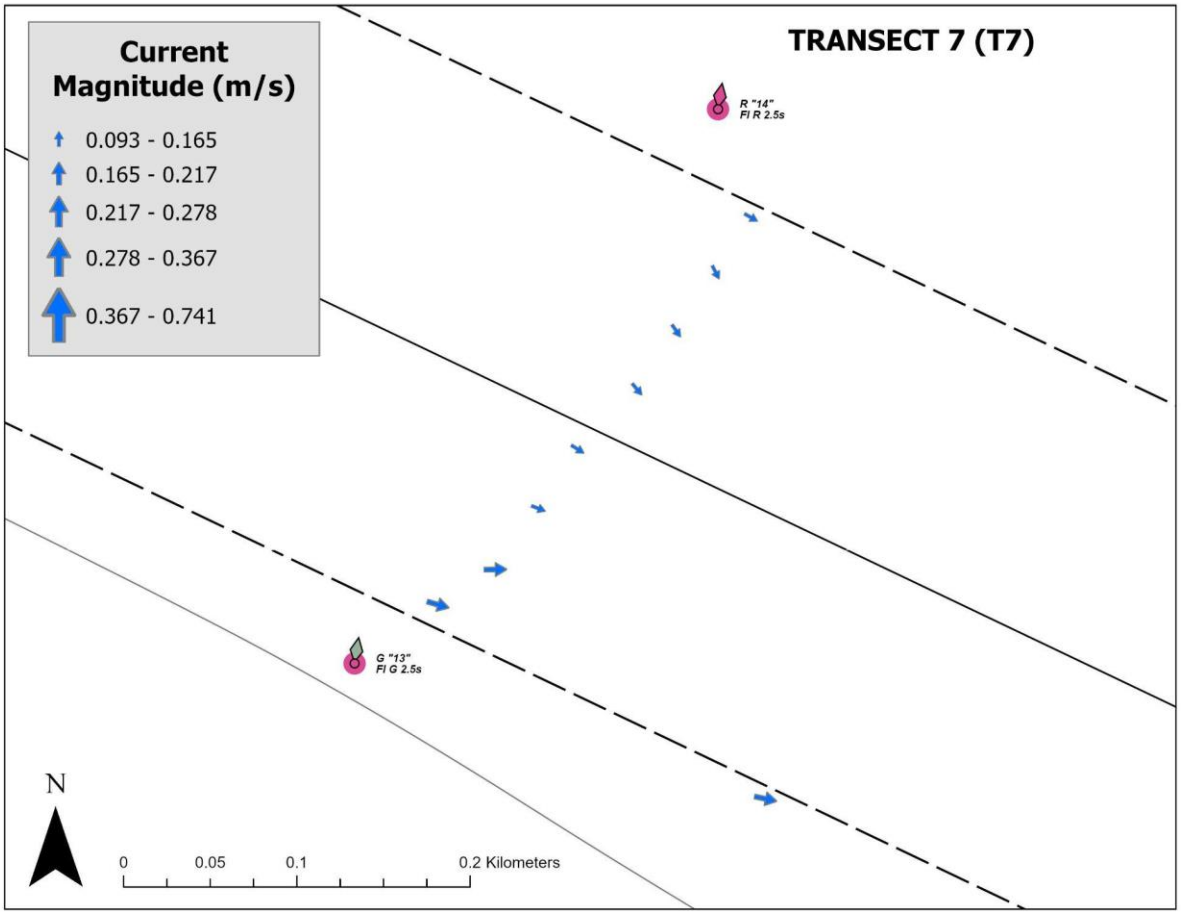

Figure 22. Depth-averaged mean velocity along Transect line 7 (T7) between aids to navigation (ATONs) 13 and 14. The blue vectors are scaled by the current magnitude and direction.

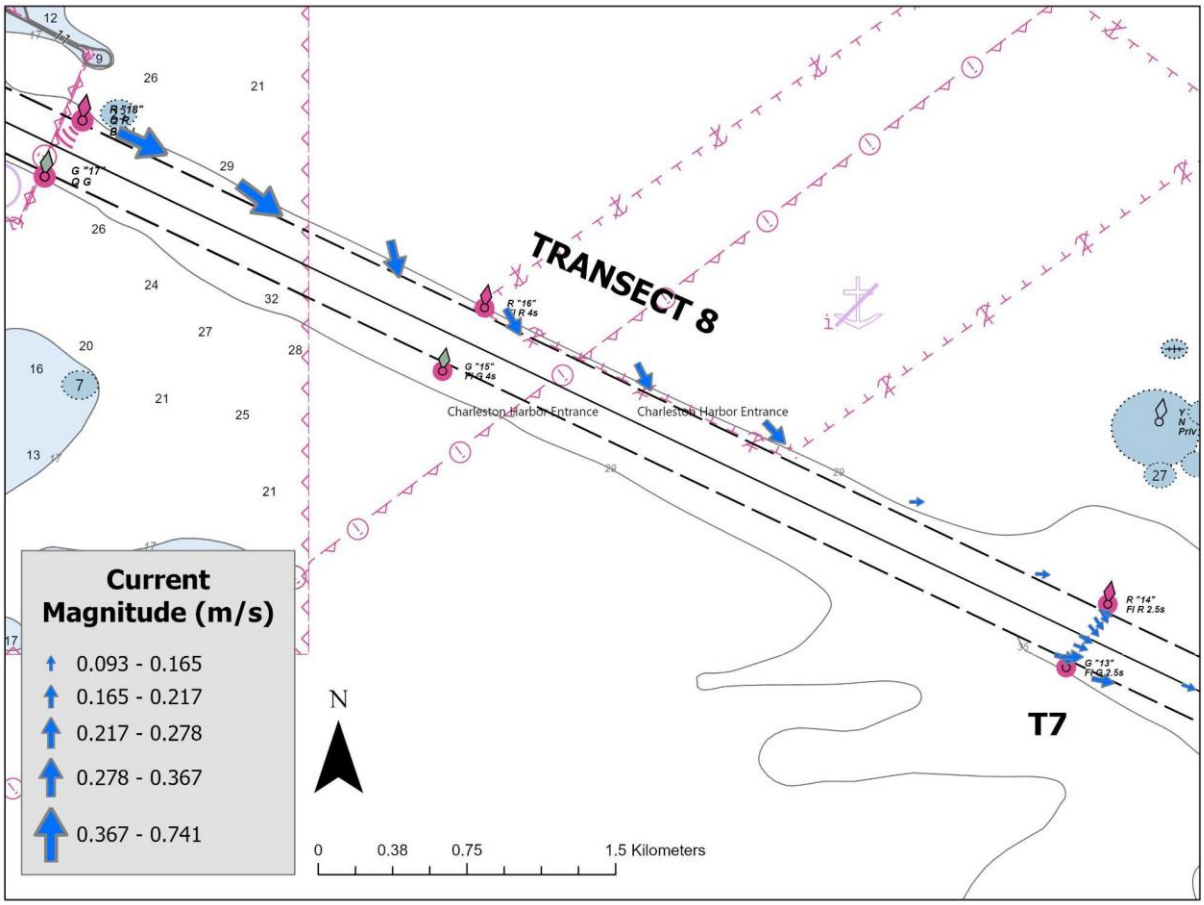

Figure 23. Depth-averaged mean velocity along Transect line 8 (T8) between aids to navigation (ATONs) 14 and 18. The blue vectors are scaled by the current magnitude and direction.

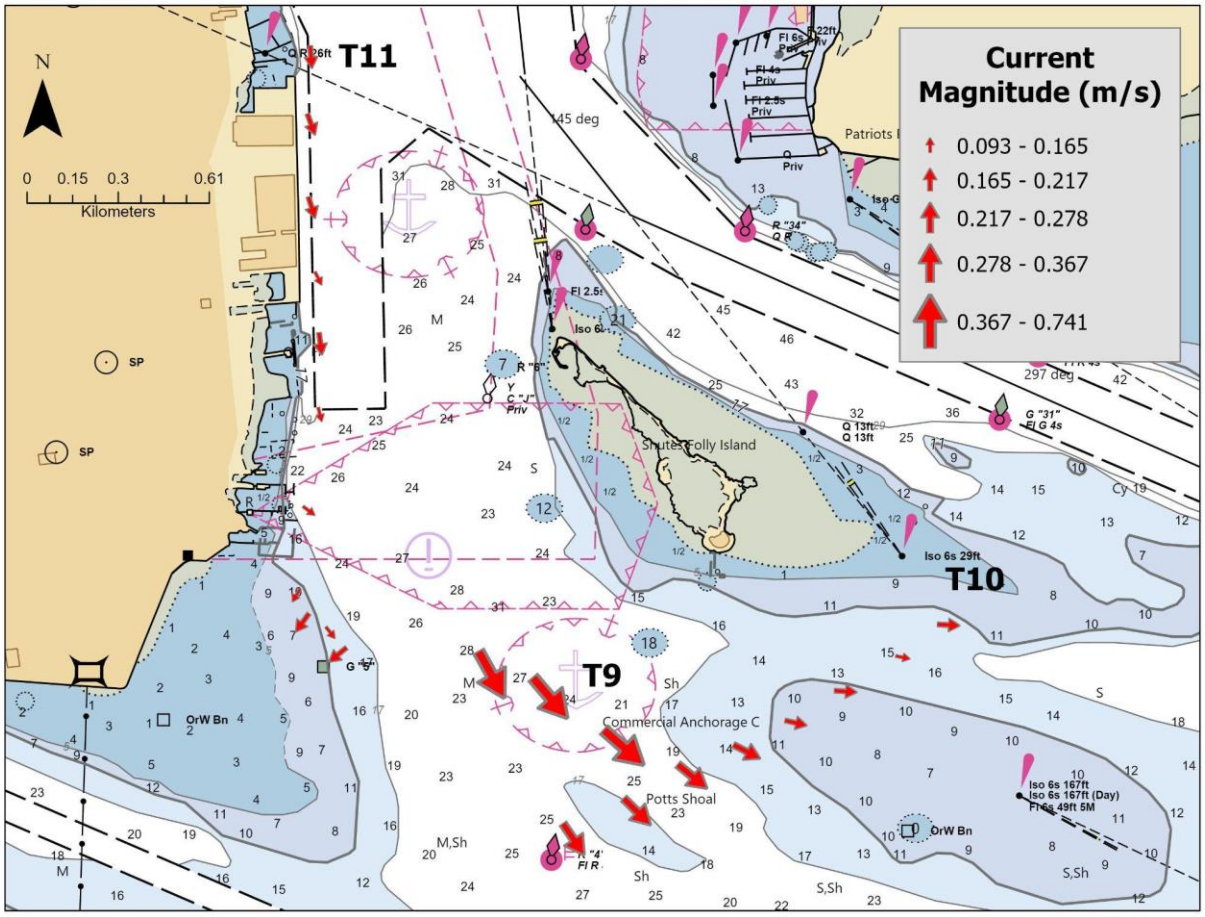

Figure 24. Depth-averaged mean velocity along Transect lines 9 (T9), 10 (T10), and 11 (T11) inside Charleston Harbor. The red vectors are scaled by the current magnitude and direction. Note, T11 vectors are alongside the Battery and have smaller vectors relative to T9 and T10.

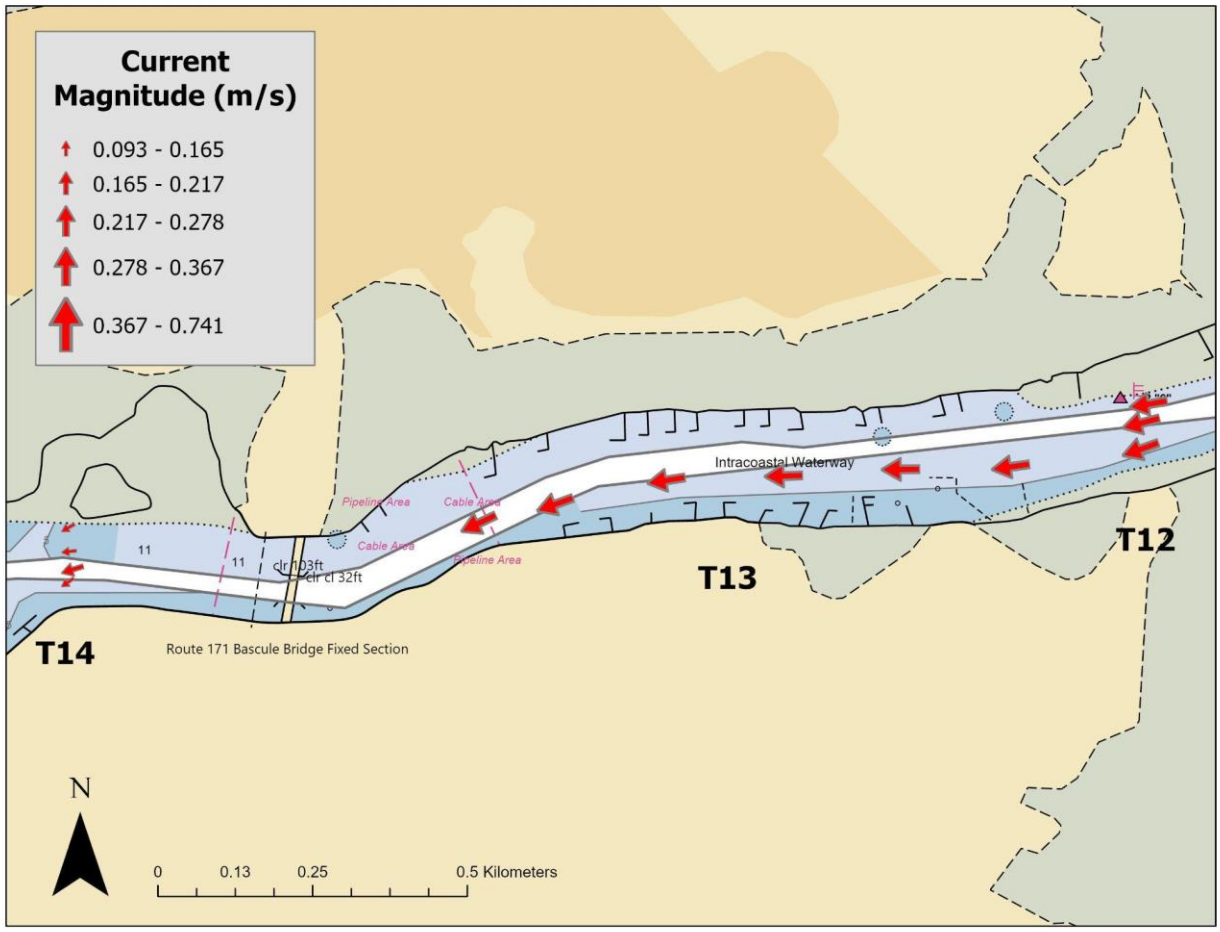

Figure 25. Depth-averaged mean velocity along Transect lines 12 (T12), 13 (T13), and 14 (T14) in Wappoo Creek, which is part of the Intracoastal Waterway (ICW). The red vectors are scaled by the current magnitude and direction.

4.0 SUMMARY

During the 2023 NOAA CO-OPS Charleston Harbor Tidal Current Survey Reconnaissance, 45 stations were temporarily occupied in the Charleston Harbor and surrounding area spanning as far south as St. Helena's Sound entrance and including the Ashley, Cooper, Wando Rivers, and the ICW. Vertical CTD casts were collected at each station to understand the water properties. Three surface GPS drifters were deployed and recovered which gave insight into the surface current velocity and trajectories in the 3 rivers. ADCP transects were completed at 14 sites in order to better understand the spatial variability of tidal currents between reconnaissance stations.

The data described in this report has been shared with NOAA and academic modelers to help support model development and validation in this area, and it is available to the public upon request (Tide.Predictions@noaa.gov).

Along with stakeholder input from modelers, academics, and the navigational community, this reconnaissance data will be used to help refine the upcoming FY24 NOAA Tidal Current Survey in the Charleston Harbor and surrounding area station list and to help define the equipment requirements at each station. The tidal current survey will involve temporarily deploying ADCPs at each station location and collecting vertical CTD casts upon deployment and recovery of the ADCP. Several CTDs may be co-located with the ADCPs in order to collect a time series of water temperature and salinity at one depth. The currents data will be used to update the tidal current predictions available online (https://tidesandcurrents.noaa.gov/) in an effort to support NOAA CO-OPS's mission of producing products to help ensure safe navigation. The CTD and ADCP data collected during the FY24 survey will also be available to the public and shared with modelers and the academic community in support of various research efforts.

ACKNOWLEDGEMENTS

Thank you to the NOAA CO-OPS Atlantic Operations Branch field crew for their efforts in collecting the data described in this report, specifically Eddie Roggenstein (CO-OPS Field Lead and vessel captain), Kris Kirby, and Tina Sepahpur. Thank you to NOAA CO-OPS's Ocean System Test and Evaluation Program (OSTEP) for their shoreside support during the field operations as well as their advanced testing of the surface drifters and Nortek VM system. Thank you to NOAA CO-OPS's Coastal and Estuarine Circulation Analysis Team (CECAT) for their support throughout the entirety of this NCOP project.

REFERENCE

Fanelli P, Paternostro C, Dusek G, Kammerer C, Park J, and Carisio A. (2014). Potential Location Assessment of Coastal and Estuarine Surveys (PLACES). NOAA CO-OPS internal report.

ACRONYMS

ADCP	acoustic Doppler current profiler
ATON	Aids to Navigation
C	Celsius
CO-OPS	Center for Operational Oceanographic Products and Services
CTD	conductivity, temperature, and depth
ft	Feet
ICW	Intracoastal Waterway
kg/m^3	Kilogram per cubic meter
m	Meter
m/s	Meters per Second
NCOP	National Current Observation Program
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NWLON	National Water Level Observation Network
OFS	Operational Forecast System
PORTS®	Physical Oceanographic Real-Time Systems
PPT	Parts Per Thousand
PSS	Practice Salinity Scale
R/V	Research Vessel
VIMS	Virginia Institute of Marine Science
VM	Vessel-Mounted