NOAA Technical Report NOS CO-OPS 025

CURRENTS IN THE ST. JOHNS RIVER, FLORIDA SPRING AND SUMMER OF 1998

Silver Spring, Maryland
September 1999

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noaa **National Oceanic and Atmospheric Administration**

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

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) collects and distributes 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 coastal 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), and a national network of Physical Oceanographic Real-Time Systems (PORTS) in major U.S. harbors. 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.

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1856 chart of the St. Johns River entrance

Richard Bourgerie

September 1999

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OF COMMERCE
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ACRONYMS AND ABBREVIATIONS

ADCP	acoustic Doppler current profiler
ADR	analog-to-digital recorder
cfs	cubic feet per second
C&GS	Coast and Geodetic Survey
CO-OPS	Center for Operational Oceanographic Products and Services
COP	Current Observation Program
DQC	data quality control
FLDEP	Florida Department of Environmental Protection
ft	feet
GOES	Geostationary Operational Environmental Satellite
ICW	Intracoastal Waterway
kHz	kilohertz
m	meters
MEC	maximum ebb current
MFC	maximum flood current
MLLW	mean lower low water
NGWLMS	Next Generation Water Level Measurement System
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NWLON	National Water Level Observation Network
PORTS	Physical Oceanographic Real-Time System
RMS	root mean square
SBE	slack before ebb
SBF	slack before flood
SJRWMD	St. Johns River Water Management District
US	United States
USACE	United States Army Corps of Engineers
UTC	Universal Time, Coordinated

ABSTRACT

The National Ocean Service's Center for Operational Oceanographic Products and Services conducted an oceanographic survey of the currents in the St. Johns River, Florida during the spring and summer months of 1998. The main goal of this survey was to collect new measurements of the currents at as many sites as feasible in the St. Johns River to update the published tidal current predictions. From the river's entrance near the Mayport Naval Station to the Trout River Cut, seven new current meter stations were occupied throughout a sixteen-mile stretch of river.

Earlier measurements of the currents in the St. Johns River were collected during surveys in 1934 and 1958 using instrumentation and methods that have long since been outdated. Over the decades, the currents have been affected by extensive dredging of channels, new harbor and channel construction, and other natural and man-made modifications. Also, because of the large military presence and heavy volume of shipping in the St. Johns River (more than 18 million tons per year), it was essential that the latest technology be applied to evaluate the adequacy of the tidal current predictions.

Several acoustic Doppler current profilers were deployed in locations throughout the St. Johns River; they have produced valuable new information on the currents in this tidal river. The results of this survey have led to the generation of new, more accurate tidal current predictions, which will serve to increase the safety and efficiency of navigation and commerce in the St. Johns River system. Because of this survey, 18 new tidal current prediction stations were added to the Tidal Current Tables, and 23 historical stations were validated, and added to the Tidal Current Tables.

In addition to the new current meter stations, a network of water level gages has been continually operating in the river for a few years. In the spring of 1995, the Florida Department of Environmental Protection, in cooperation with the St. Johns River Water Management District, installed 13 water level gages along approximately a 100-mile stretch of the river. Data from two of these water level stations have been harmonically analyzed to produce new tide predictions, which are now incorporated into the NOS Tide Tables.

1. INTRODUCTION

The National Ocean Service's (NOS) Center for Operational Oceanographic Products and Services (CO-OPS), manages the Current Observation Program (COP). This program's goal is to improve the quality and accuracy of the NOS Tidal Current Tables, which are published annually. Improving this information is a critical part of NOS's efforts toward promoting safe navigation in our Nation's waterways. CO-OPS acquires, archives, and disseminates information on tides and tidal currents in U.S. ports and estuaries; this has been a vital NOS function since the 1840s. Mariners have always required accurate and dependable information on the movement of the waters in which they navigate. Ships have doubled in length, width, and draft in the last 50 years and seagoing commerce has tripled, leading to increased risk in the Nation's ports (USACE, 1997).

The existing suite of NOS tidal current prediction stations are presently based on limited data sets that have rarely, if ever, been updated. Over two-thirds of NOS's more than 3,000 tidal current prediction stations are based on data that are more than 40 years old (Earwaker, 1999). To allow for the continued support of these tidal current predictions, with shrinking government resources, cost-effective methods are being established to maintain the Current Observation Program.

The circulation dynamics of an estuary or tidal river are modified by natural factors, and man-made alterations such as the dredging of channels, harbor construction, bridge construction, the deposition of dredge spoils, and diversion of river flow. These changes in the tidal regime and subsequent water flow can occur rapidly or over several decades, and will, by their nature, affect the accuracy of tide and tidal current predictions. New data must be collected periodically to assure that the information is reliable; the alternative is to distribute tide and tidal current predictions based on potentially inadequate and outdated information, or to stop distribution altogether.

1.1 Previous Measurements of Currents and Water Levels in the St. Johns River

The Coast and Geodetic Survey (C&GS), the predecessor of NOAA, last conducted measurements of the currents in the St. Johns River in 1934 and 1958 using current poles and Roberts Radio current meters. Eighteen stations yielded data of good quality, and predictions have been published for these stations for many years. Most of the observation periods ranged from three to eight days, except the reference station, "St. Johns River Entrance," which consisted of two 15-day periods (Haight, 1938).

The type of current pole used in the 1930s was a 15-foot pole of white pine, 2 3/4" in diameter, submerged 14 feet with an attached graduated log line. The pole was weighted at the lower end to cause it to float upright with the top about one foot out of the water. Every 30 minutes, the current was measured continuously for 60 seconds, with a stopwatch, and logged to a file (C&GS, 1926).

The Roberts radio current meter was a big improvement over the current pole. It was an automated electronic system that eliminated the necessity of maintaining a crew and vessel during the entire observation period. The meters were suspended from an anchored mooring connected to a 10 ft. surface buoy. A rotating impeller was actuated by the current flow; the meter was able to measure current speeds ranging from 0.1 knots to seven knots. Current directions were accurate to within

10 degrees. The data were relayed by VHF telemetry to a remote base station, generally every 30 minutes, and logged to a file (C&GS, 1950).

Approximately 43 water level stations along the St. Johns River have been occupied by NOS since 1923, although most of the stations were established and removed during the mid-to-late 1970s. Before this survey, 32 stations on the St. Johns River were published in the annual NOS Tide Tables (NOS, 1999a). The water level station at Mayport is part of the NOS National Water Level Observation Network (NWLON) and has continuous observations since April of 1928.

Prior to 1989, NOS measured water levels with systems that utilized an analog-to-digital recorder (ADR) driven by a float within a stilling well. Water level data were recorded on punched paper tape at 6-minute intervals. Each measurement was a discrete instantaneous value measured when the wire leading to the float was mechanically locked in place while the ADR unit punched the paper tape with a binary code representing the value of the water level. Measurements were recorded with 0.01 foot resolution. A local "tide observer" would periodically remove the paper data roll and mail it to NOS headquarters for processing and analysis (Mero, 1988).

In 1985, NOS embarked on a major upgrade of the NWLON. This network presently consists of about 175 continuously operating water level stations around the US coast (including the Great Lakes), and several Atlantic and Pacific islands. The stations are now equipped with measurement systems called Next Generation Water Level Measurement Systems (NGWLMS). The NGWLMS uses acoustic sensors, electronic data storage, and backup pressure sensors. The systems are also equipped to ingest ancillary sensor data, such as wind speed and direction, barometric pressure, air temperature, water temperature, and salinity. The data are telemetered every one to three hours, via NOAA's Geostationary Operational Environmental Satellite (GOES), to NOS headquarters for processing, analysis, archival, and dissemination (Mero, 1998).

1.2 General Description of the St. Johns River

The St. Johns River (SJR) is the longest river in Florida, meandering more than 300 statute miles–it is an unusual river in that it flows from south to north. The source of the river (its headwaters) is a broad marsh area about 15 miles west of Vero Beach; the river ends at the Atlantic Ocean at Mayport. The St. Johns River is considered a "lazy" river--the total elevation drop from its headwaters to the Atlantic Ocean is less than 30 feet, an average slope of about one inch per mile (NOS, 1998).

Over its entire length, the river's average depth is relatively shallow. However, the 26-mile stretch of river from the mouth to downtown Jacksonville (the deepest segment) has an average depth of approximately 30 ft. (Morris, 1995). The main navigation channel, extending about 23 miles inland from the mouth, is presently dredged to 38 feet. Plans are currently underway to deepen the channel to 40 feet. Many small rivers, creeks, and tributaries feed into the St. Johns River, increasing the overall river flow, and affecting the tidal signal, especially during storm events. Some of the larger rivers and creeks along the lower portion of the St. Johns River include: Pablo Creek, Sisters Creek, Clapboard Creek, and Cedar Point Creek. Others, farther upriver, include: Dunn Creek, Broward River, Trout River, Arlington River, and Ortega River.

The St. Johns River runs through the city of Jacksonville, which is the largest city in the state of Florida–it has boundaries from the ocean to more than 35 statute miles upriver. Jacksonville is a major southeastern deepwater port, handling more than 18 million tons per year of cargo. Principal exports include paper products, phosphate rock, fertilizers, and citrus products. Principal imports include petroleum, coffee, limestone, automobiles, and lumber (USACE, 1997). Deep-draft vessels transit as far as downtown Jacksonville, or about 24 statute miles upriver. Beyond this point, commercial traffic is light and consists almost entirely of oil barges (NOS, 1998).

The climate of the St. Johns River basin is classified as a "humid subtropical" zone. Daily maximum temperatures in the summer average approximately 90° F; below-freezing temperatures generally occur about a dozen times per year in the winter. The rainy season is from late summer to early fall, while the drier months occur during the winter (NOS, 1998).

The effect of the tides on the river is significant. Tidal influences are prevalent from the mouth of the river to slightly more than 100 statute miles upriver, near Georgetown, where the tide becomes negligible. The exact point where the river becomes nontidal will constantly change, depending on the strength of the tide signal (e.g., spring or neap tides), and the interaction of the tide with the variable river flow. Tidal effects have been reported as far south as Lake Harney, upstream of De Land (NOS, 1993).

The total flow in the river is comprised of about 80%-90% tide-induced flow, with the remaining flow caused by wind, freshwater inflow (from tributaries and rain), and industrial and treatment plant discharges. The river flow generally increases downstream, with the highest flows occurring at the mouth of the river. The total discharge of the river is normally greater than 50,000 cfs and can exceed 150,000 cfs. River flow is seasonal, generally following the seasonal rain patterns, with higher flows occurring in the late summer to early fall, and the lower flows occurring in the winter months. The average annual nontidal discharge at the river mouth is approximately 15,000 cfs (NOAA, 1985).

2. PROJECT DESCRIPTION

In the past sixty years, the currents (and to a lesser extent, the water levels) in the St. Johns River have been significantly affected by extensive dredging of channels and harbors, new channel construction, and other natural and man-made modifications that have occurred over the years. Because of the large military presence and heavy volume of shipping in the St. Johns River (more than 18 million tons per year), it was essential that the latest technology be applied to evaluate the reports of inadequate tidal current predictions.

From mid-April through mid-September 1998, CO-OPS conducted an oceanographic survey of the currents in the St. Johns River. The purpose of this survey was to evaluate reports of decreased reliability and usefulness of the published NOS Tidal Current Tables. Seven current meter stations were strategically selected (Figure 1.1) to collect new data and produce new tidal current predictions at critical sites where the local maritime community expressed a need for more accurate information.

In addition to the new current meter sites, a network of water level gages has been continuously operating in the river since the spring of 1995. The Florida Department of Environmental Protection (FLDEP), in cooperation with the St. Johns River Water Management District (SJRWMD), installed and maintains 13 water level gages along more than a 90-mile stretch of the river. Figure 1.1 shows the locations of six of these gages. As part of this project, the six-minute data from two of these water level stations were harmonically analyzed to produce new tide predictions, which are now incorporated into the NOS Tide Tables.

2.1 Station Locations and Observation Periods

A summary of the current meter stations deployed during this survey is presented in Table 1.1. Station names, numbers, positions, depths, and dates are presented. Because of limited resources and time constraints, only seven stations were occupied during three different 7-8 week periods. The total station occupation periods ranged from 48 days to a maximum of 96 days (Figure 1.2).

The station, “St. Johns River Entrance” (**J1**) was selected because this location is one of NOS’ 48 Tidal Current Reference Stations. It had been 64 years since NOS conducted measurements at this site. This is a critical site for the St. Johns River Bar Pilots. Published navigational guidelines require all vessels with more than 32 feet of draft, and tows, to base their inbound and outbound movements on predicted tidal currents at this station (NOS, 1998). During this survey, there were 96.0 continuous days of good data collected at this station.

The “Mayport Basin Entrance” station (**J2**) was requested by the Naval Station Mayport. Naval Pilots have been concerned for many years with the cross-channel currents that the Navy ships and tugs frequently encounter (particularly on an ebb flow) when transiting in and out of the basin. During this survey, there were 48.0 continuous days of good data collected at this station.

The Naval Station Mayport also requested a current meter station be placed within their basin, to help understand the nature of the water circulation, especially during the maneuvering of ships. To this end, the “Inner Mayport Basin” station (**J3**) was deployed. There were 48.3 continuous days of data collected at this station; unfortunately, the current meter was placed too close to the south side of the basin, and the measured currents were weak and variable. The majority of current speeds were measured at less than 1/4 knot, therefore the data were considered unusable.

Table 1.1 St. Johns River current meter station deployment information.

Station	Station Name	Position	Water Depth (MLLW)	# Days Data	Deployment Period
J1	St. Johns River Entrance	30° 24.022' N 081° 23.154' W	50.8 ft. (15.5 m)	96.0	04/16 - 07/21 1998
J2	Mayport Basin Entrance	30° 23.820' N 081° 23.929' W	43.0 ft. (13.1 m)	48.0	06/03 - 07/21 1998
J3	Inner Mayport Basin	30° 23.661' N 081° 24.403' W	37.1 ft. (11.3 m)	48.3	06/04 - 07/22 1998
J4	Intracoastal Waterway Intersection	30° 23.020' N 081° 27.519' W	53.8 ft. (16.4 m)	49.8	04/15 - 06/04 1998
J5	Dames Point Bridge	30° 23.078' N 081° 33.276' W	39.0 ft. (11.9 m)	22.6	07/23 - 08/15 1998
J6	Trout River Cut	30° 23.029' N 081° 37.694' W	43.3 ft. (13.2 m)	55.5	07/22 - 09/16 1998
J7	East Blount Island	30° 23.521' N 081° 30.511' W	44.3 ft. (13.5 m)	54.0	07/23 - 09/15 1998

The "Intracoastal Waterway (ICW) Intersection" station (**J4**) was one of the highest priority station's requested by the St. Johns River Bar Pilots. In this area, it was reported that ships frequently encounter unpredictable cross-channel currents at various stages of the tide, especially during high streamflow conditions. In addition, many tugs and tows cross over the river while transiting the ICW, further complicating navigation. Prior to this survey, there were no tidal current predictions published for this junction of the river. During this survey, 49.8 continuous days of good data were collected at this station.

The "East Blount Island" station (**J7**) is another point in the river where it was reported that unpredictable cross-channel currents are encountered. Before this survey, there were no tidal current predictions published for this junction of the river. In addition, the Navy maintains a large storage facility along the Back River, and they were interested in collecting new information on the currents in this area. During this survey, 54.0 continuous days of good data were collected at this station.

The "Dames Point Bridge" station (**J5**) was deployed in an area of particular concern for large vessels transiting the river. Just to the west of this station, there is a sharp turn in the river. Pilots have reported their ships being "set deep into the bend" on both the flood and the ebb, presumably from cross-channel currents from the Blount Island Channel. In addition, vessels use this area of the channel as a turning basin when using the Blount Island Terminal (NOS, 1998). Due to instrument battery failure, only 22.6 days of continuous good data were collected at this station.

The “Trout River Cut” station (**J6**) was requested by the St. Johns River Bar Pilots because of the effect of the Trout River on the currents in the main shipping channel. This location is the farthest upriver of the seven stations occupied during this survey. Cross-channel currents are reported to “set across the channel on both the flood and ebb.” Also, there are many oil terminals in this area, on the west bank, adding to the pilots’ concerns (NOS, 1998). This location is one of the existing 17 subordinate tidal current stations that have been published for many years, however, it had been 40 years since NOS conducted new measurements at this site. During this survey, 55.5 continuous days of good data were collected.

Original survey plans included the deployment of a current meter farther upriver in downtown Jacksonville, near the FEC railroad bridge. However, logistical constraints and instrumentation recovery concerns (reports of bottom debris and bridge construction), prompted a last-minute change in plans, and this current meter was placed at the Dames Point Bridge (station **J5**).

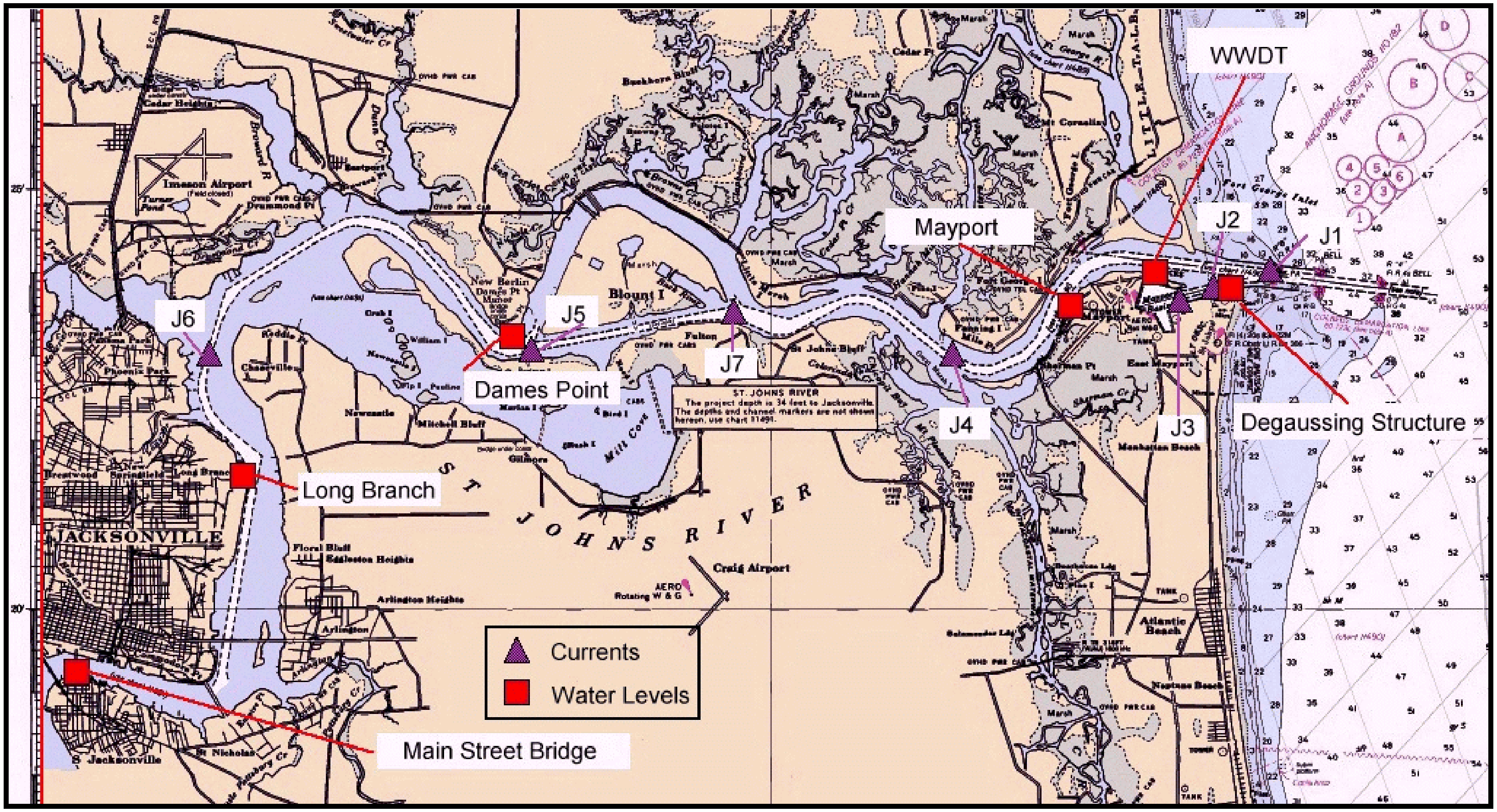

Figure 1.1 Chartlet of the station locations: current meters and water level gages.

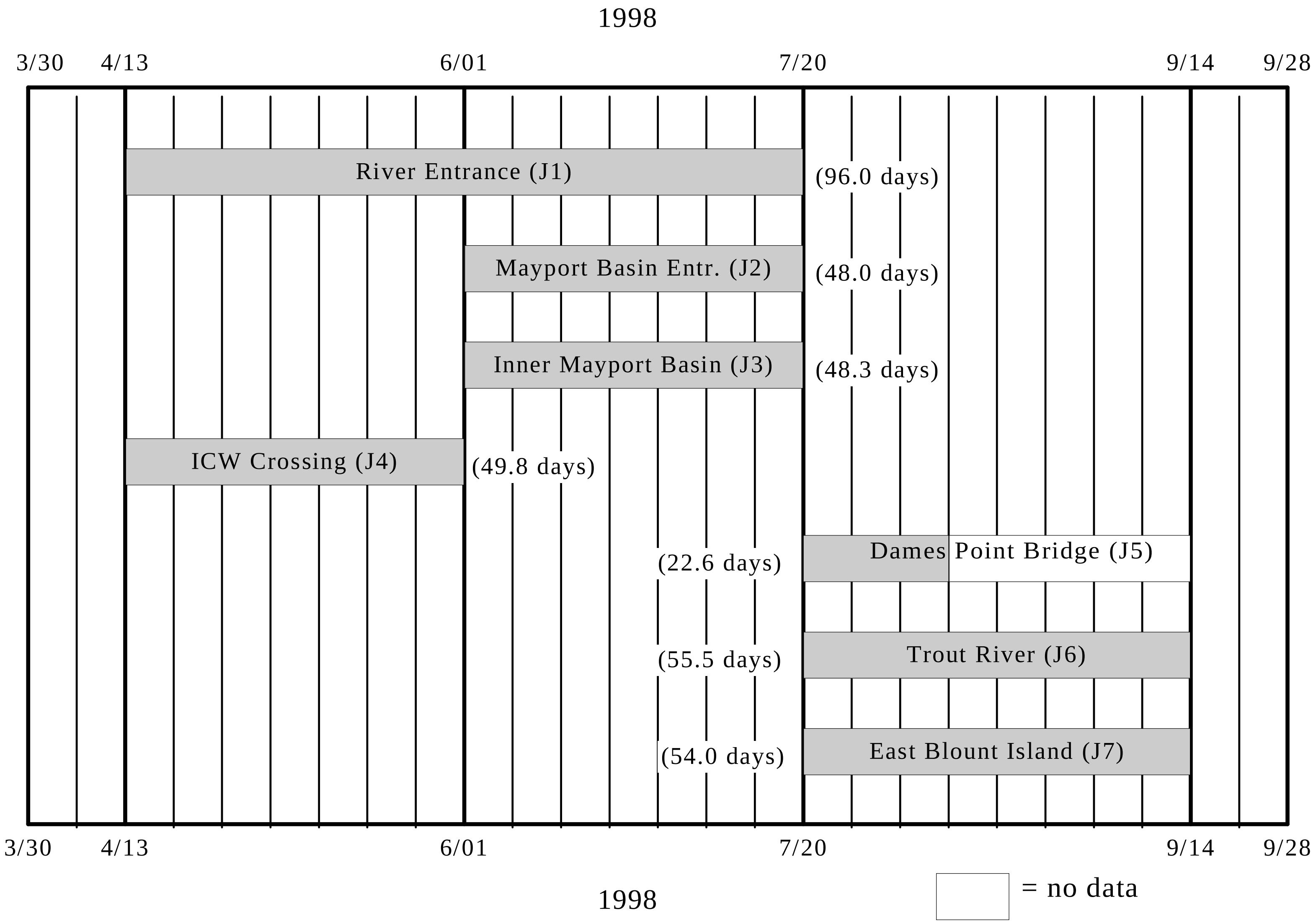

Figure 1.2 Time-line of the current meter station deployments.

2.2 Instrumentation and Sampling Methods

RD Instruments (RDI) “Workhorse Sentinel” acoustic Doppler current profilers (ADCP) were used at all of the current meter stations in this survey (Figure 2.1). NOS personnel have deployed dozens of RDI ADCPs in various harbors and estuaries throughout the U.S. for more than 10 years; these instruments have a proven reliability and performance. The advent of ADCP technology has enabled NOS to obtain water current data throughout an entire water column with long-term theoretical accuracies of approximately 0.02 knots or better (RDI, 1996).

Figure 2.1 RDI Workhorse ADCPs used for this survey.

The ADCP computes current velocities throughout a water column by measuring the Doppler shift of a fixed-frequency sound transmission. Sound scatterers in the water (i.e., plankton, particles, air bubbles) reflect the transmitted sound back to the ADCP in the form of a "backscattered" echo. The ADCPs used in this survey have four acoustic transducer heads equally spaced in the azimuth, known as the “JANUS” configuration. They have four transducers angled at 20 degrees from the horizontal, and operate at a frequency of 300 kHz.

The most important feature of the ADCP is its ability to *remotely* measure current profiles, which are divided into uniform segments called depth cells or "bins" (Figure 2.2). All of the current meters used in this survey were programmed to collect and internally record data at six minute intervals, in 1 meter bin lengths throughout the water column.

All of the current meters were deployed on the river bottom in an upward-looking configuration, on platforms specially designed for instrument protection and leveling: Flotation Technologies Trawl Resistant Bottom-Mounts (Figure 2.3) were used. These platforms have the shape of a truncated pyramid (with the sides angled at approximately 35° from horizontal) built to lift and deflect passing trawl-type fishing gear. They have overall dimensions of 6 ft. × 6 ft. × 1.7 ft. Their weight in air is approximately 800 pounds, including the lead ballast.

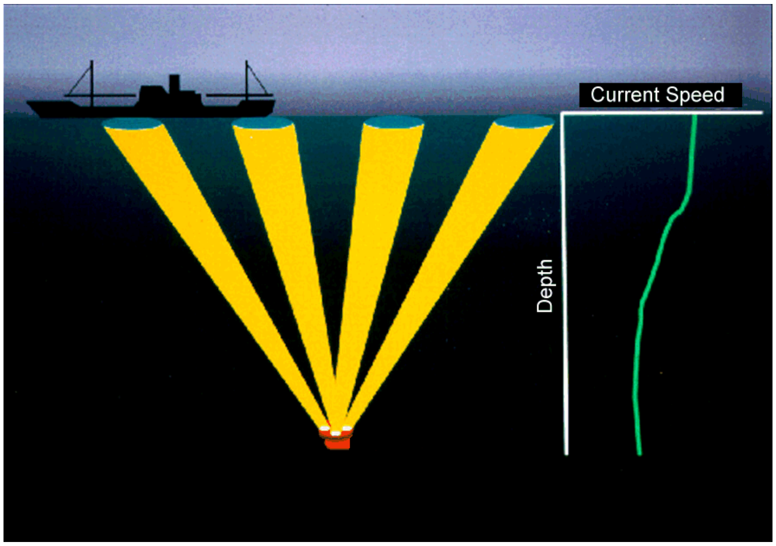

Figure 2.2 Illustration of the profiling ability of a bottom-mounted ADCP.

The bottom-mounts consist of three main components: a base section made of corrosion resistant aluminum, a recovery pod made of syntactic foam, and a gimbal mechanism made of machined PVC. The gimbal mechanism orients the ADCP to vertical at bottom slopes of up to 20°. An acoustic release, housed in the recovery pod, is used for recovering the package. Upon activation of the acoustic release, the recovery pod floats to the surface and the attached line is used to haul the base onto the ship. One interesting feature of this bottom-mount is that most of the buoyancy is situated on the top half, making it self-righting in "free-fall" when placed in the water at angles up to and even beyond 90 degrees.

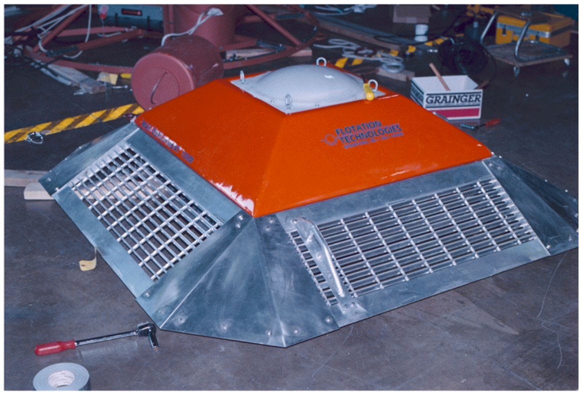

Figure 2.3 Flotation Technologies, Inc. bottom-mount used for the survey.

Because these bottom-mounts present a relatively low profile, they were all placed directly in the main navigation channel, usually in a deeper section, as determined from the latest hydrographic survey sounding data. This provided more representative and useful current measurements than if the current meters had been placed on the edge of the navigation channel (as was often necessary with older technology) to avoid becoming a hazard to navigation.

2.3 Data Processing and Quality Control

After the bottom-mounts and current meters were recovered and brought to shore, the raw data were downloaded from the ADCP's internal recorder to a laptop PC. The data were then transported to NOAA headquarters in Silver Spring, Maryland, where they were subjected to a set of standard data quality control (DQC) procedures and thoroughly processed and analyzed. The data were converted from instrument format (binary ADCP) into ASCII engineering units for analysis. Data were then checked for time validity, outliers, trends, and noise bursts. Time-series plots were created for each station for the various measured parameters.

Each data set was checked for instrument tilts greater than 15 degrees. Any data record that had an instrument tilt of greater than 15 degrees was not used for analysis. Similarly, if there were any sudden movement of the bottom-mount (illustrated by the tilt sensor, compass, and pressure sensor), the data were scrutinized because a significant movement of the bottom-mount may have occurred. This only occurred in one of the data sets for a relatively short time period.

In order to compute the water depth (from the surface) of each depth cell, some simple computations are required. First, the distance above the bottom for the center of each depth cell is calculated. To obtain these, three values are added:

1) the height of the ADCP acoustic heads off of the river bottom;
2) the depth cell length;
3) the "blanking distance".

For all of the deployments, these three parameters were fixed at 0.6 m, 1.0 m, and 1.7 m, respectively. To this total, a speed of sound correction of about 0.2m (based on measured water temperature and estimated conductivity) is added. This gives a "fixed" height above the bottom (for the first depth cell) of 3.5m for all stations. The second depth cell is 4.5m off of the bottom, and the nth depth cell is (n+2.5) m above the bottom.

Finally, to determine the water depth of each depth cell, the distance above bottom for a given depth cell is subtracted from the total station depth, which was either computed directly from the ADCP's internal pressure sensor or estimated from a fathometer and/or bathymetric soundings.

Because of acoustic side lobe interference effects near the river surface, in which the vertically oriented side lobes combine with the 20-degree main beam, the ADCP data are not assured valid in the top 6% of the water column (RDI, 1996). Even with this limitation, good data were collected very near the surface at each of the seven stations. Depending on the total station depth, the shallowest depth having good data ranged from five to 10 feet below MLLW.

3. CURRENTS

Currents in the lower St. Johns River are tidally dominated. Because the river is basically a constricted channel, the currents are rectilinear (or reversing), in that the water flows alternately in approximately opposite directions, with a slack water at each reversal of direction. The currents are semidiurnal, consisting of two flood and two ebb periods each day.

In the 16-mile stretch of river studied in this survey, the currents exhibit mostly progressive wave characteristics, meaning that the maximum strengths of flood and ebb occur *near* the times of high and low water, respectively. This relationship varies along the river (Figure 3.1), depending on the distance from the mouth of the river, the water depth, and other physical factors. At the river entrance, the maximum flood and ebb currents occur approximately one hour before the high and low tides at the river entrance (Figure 3.2). Further upriver, at Dames Point (approximately 10.5 miles from the river entrance), the maximum flood and ebb currents precede the times of high and low water by only about 15-35 minutes (Figure 3.3). Somewhere around 15 to 17 miles from the river entrance, the flood and ebb strengths occur almost simultaneously with the times of high and low waters (Figure 3.1).

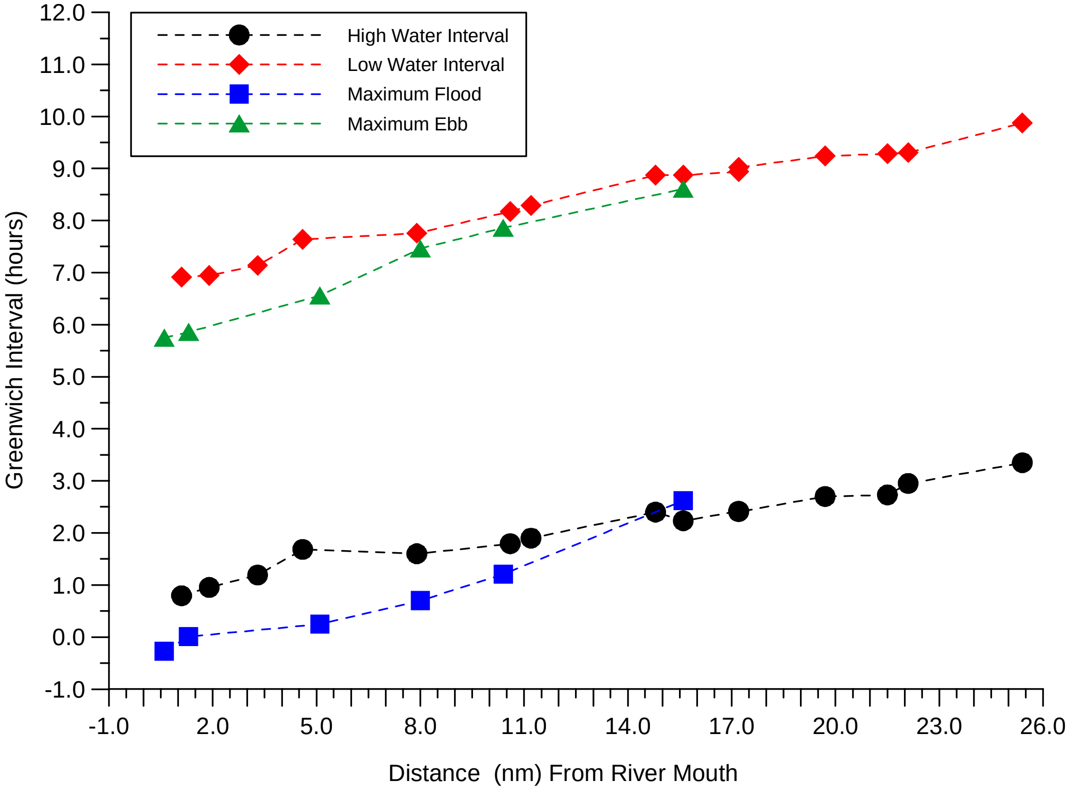

Figure 3.1 Time differences, from the river mouth, of two tide and two tidal current phases. Note that the tidal current phases are for depth cells nearest 15 feet.

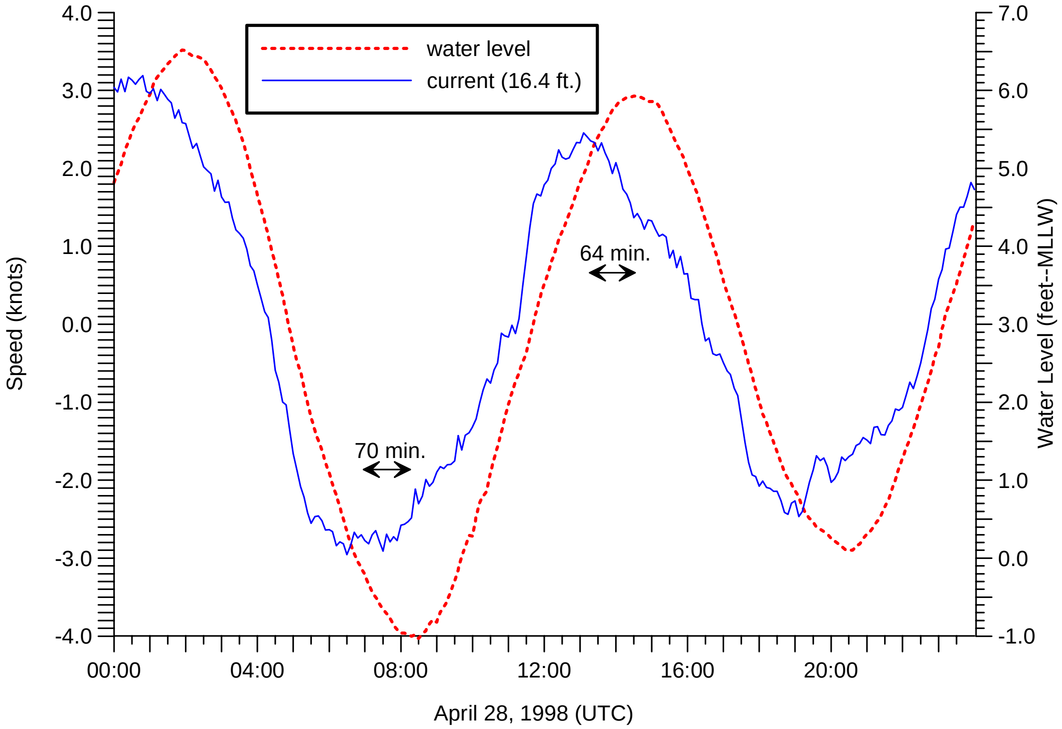

Figure 3.2 Phase lag of water level at Mayport D.S. and current at the River Entrance (J1). Note that both plots are actual observations, while the time differences are mean values.

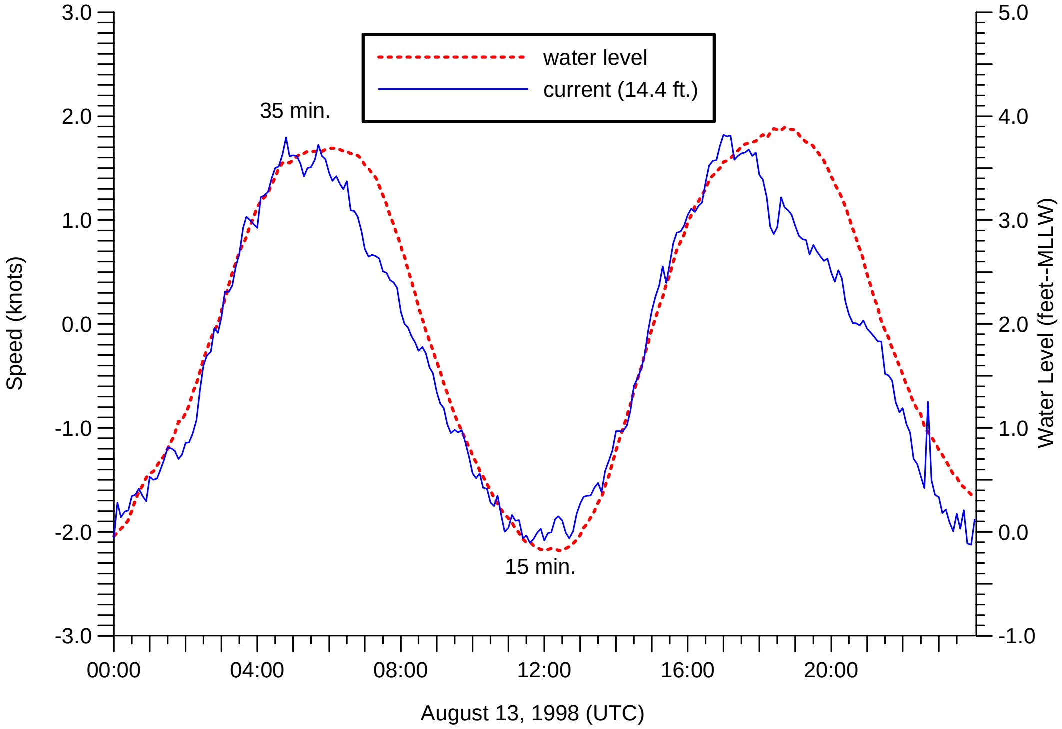

Figure 3.3 Phase lag of water level and current at Dames Point. Note that both plots are actual observations, while the time differences are mean values.

The progression of the tidal current from the mouth of the river to the Trout River Cut station (**J6**) is highly linear. In this approximately 16-mile stretch of river, there was a measured time difference of 2.3 to 2.9 hours (Figure 3.4) for all four of the tidal current phases–slack before flood (SBF), maximum flood current (MFC), slack before ebb (SBE), and maximum ebb current (MEC). This corresponds to an average progression speed of about 5.5 to 7.0 knots, which is important information to mariners when planning for the most efficient times to transit up or down the river.

This direct linear relationship of the tidal current phases along the river was used as a tool to verify all of the older (1934 and 1958) published tidal current prediction stations. After the final analysis, only one old station was removed from the tidal current tables because the timing of its tidal current phases fell far outside of the interpolated tidal current phase progression line.

The currents at all of the stations exhibited vertical profiles that are typical of tidal rivers. Figure 3.5 shows the deployment-averaged vertical profiles from all of the stations. The current speeds were strongest near the surface (due to bottom frictional effects), and the down-river stations generally had stronger currents than the up-river stations.

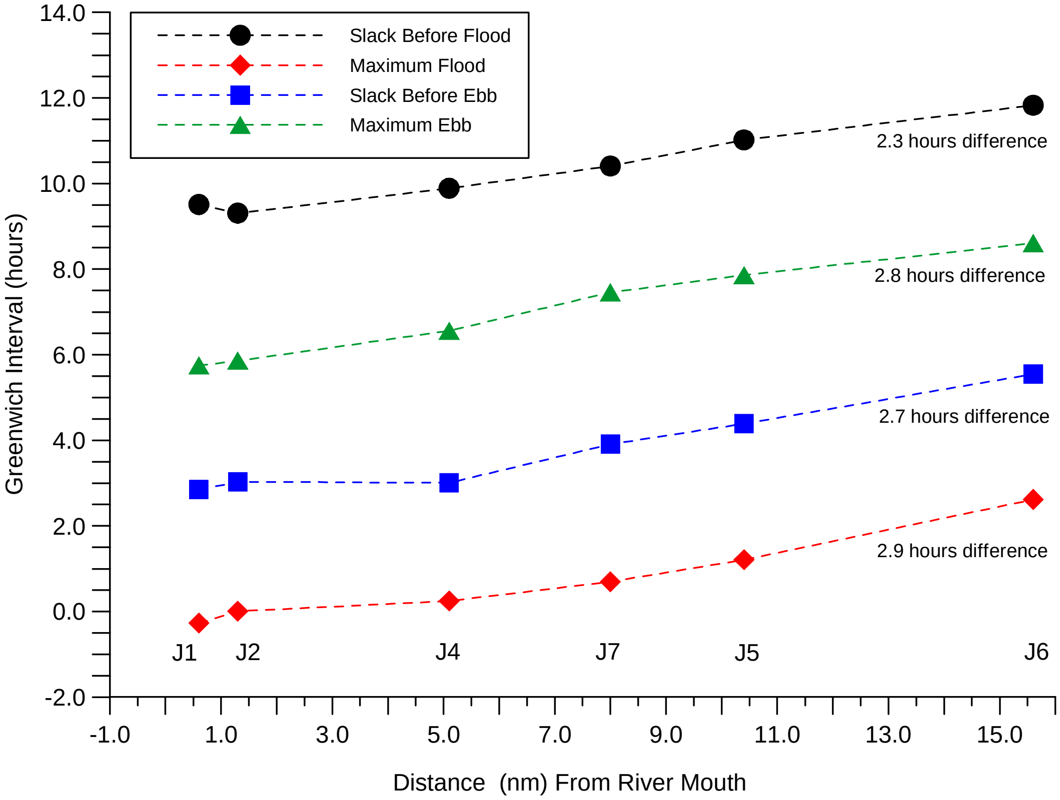

Figure 3.4 Time differences, from the river mouth, of the four tidal current phases. Note that all of the values are for depth cells nearest 15 feet.

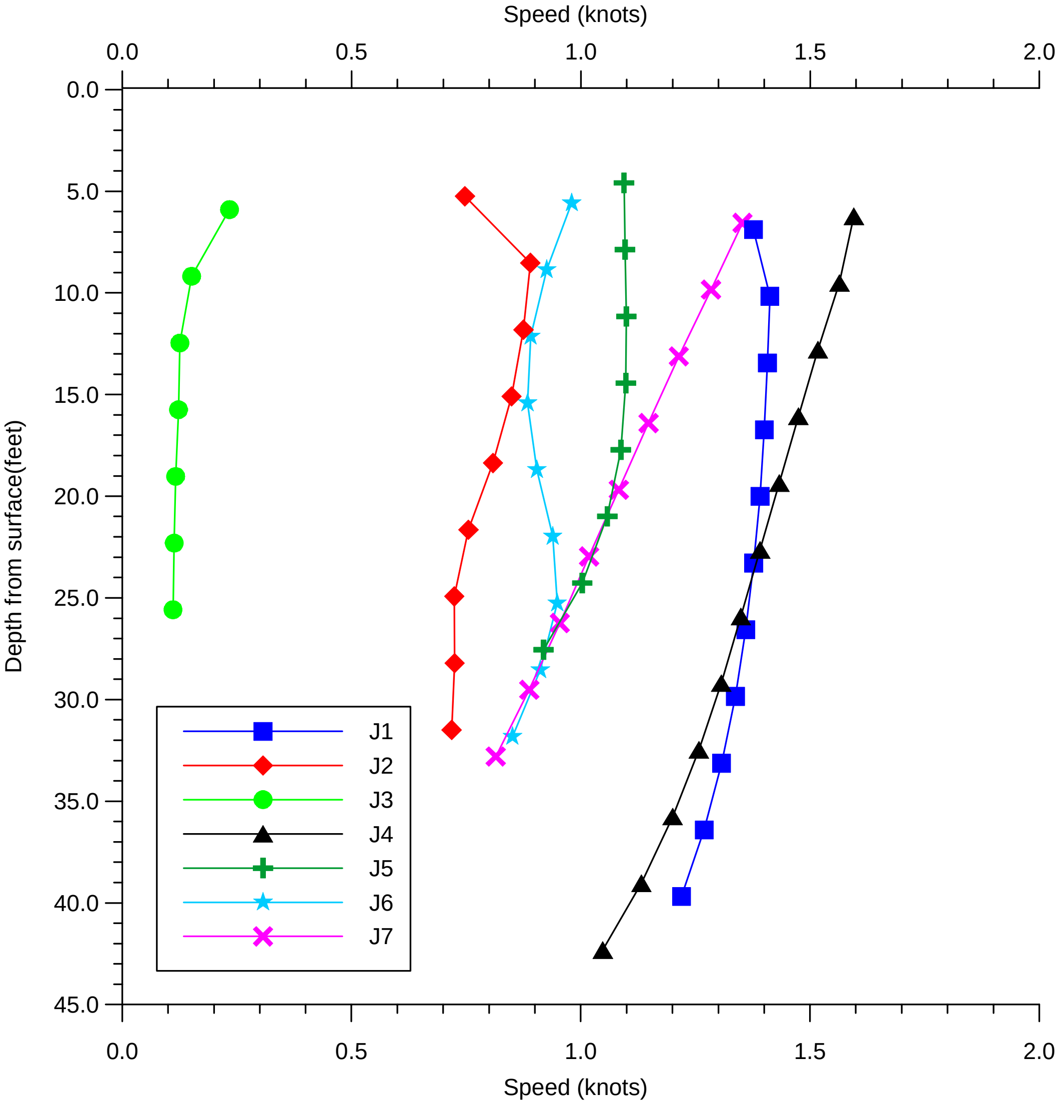

Figure 3.5 Vertical profiles of mean current speeds at all stations.

3.1 Harmonic Analysis and Tidal Constituents

The currents in the St. Johns River are primarily driven by the astronomical tides coming from the continental shelf in the South Atlantic Bight. The astronomical tides consist of a set of sinusoidal waves, known as tidal constituents, at a finite number of discrete frequencies. Harmonic analysis is the primary method used to solve for tidal constituents. Using the tidal current constituents, computed from measured data, the tidal currents can be predicted for any given time into the relatively near future. While NOS routinely performs many other analyses on current meter data, harmonic analysis is the most important. It is the foundation upon which all tide and tidal current predictions are based.

Two different harmonic analysis methods were used on the data collected in this survey. Least squares harmonic analysis (Harris et al., 1963) was performed on the five stations that had 48 days or more of data, and Fourier harmonic analysis (Dennis and Long, 1971) was performed on the Dames Point station (J5), which collected only 23 days of data. The five principal tidal current harmonic constituents computed for the six stations are listed in Table 3.1. They are listed in order from down-river to up-river, with three depths each. In general, all of the epochs (phases) increase upriver, which is typical for a tidal river.

Table 3.1 Principal tidal current constituents: amplitudes (along-channel in knots) and epochs (kappas) of the five most significant tidal current constituents. Stations are listed from down-river to up-river.

Station	Depth (ft.)	M_2		S_2		N_2		K_1		O_1	
		Amp.	Epoch	Amp.	Epoch	Amp.	Epoch	Amp.	Epoch	Amp.	Epoch
J1	9.8	2.02	195.6	0.24	215.1	0.42	168.1	0.21	76.0	0.17	93.7
J1	16.4	2.01	194.1	0.24	216.7	0.40	167.6	0.21	74.4	0.17	91.5
J1	29.5	1.91	191.2	0.23	220.1	0.38	167.7	0.20	70.6	0.17	89.7
J2	8.5	1.25	195.0	0.09	176.5	0.18	160.9	0.15	73.6	0.05	92.8
J2	15.1	1.22	194.6	0.08	189.1	0.18	163.9	0.15	69.6	0.07	91.7
J2	31.5	0.91	205.7	0.08	197.8	0.13	174.2	0.12	81.0	0.10	109.7
J4	9.5	2.10	207.2	0.28	220.9	0.43	173.5	0.27	64.4	0.19	93.6
J4	16.1	2.03	205.3	0.28	221.3	0.42	174.2	0.26	60.3	0.19	95.4
J4	29.2	1.81	200.4	0.25	220.1	0.39	174.9	0.23	56.1	0.18	90.5
J7	6.6	1.85	230.1	0.21	253.5	0.29	211.7	0.18	129.8	0.12	121.3
J7	16.4	1.58	225.5	0.18	247.4	0.25	204.4	0.16	125.1	0.12	123.2
J7	29.5	1.22	222.6	0.16	248.9	0.22	201.8	0.13	121.8	0.08	130.4
J5	4.6	1.54	245.0	0.17	266.1	0.30	233.7	0.15	113.8	0.07	149.3
J5	14.4	1.60	240.6	0.19	267.3	0.31	227.0	0.14	115.3	0.06	134.9
J5	27.6	1.30	244.6	0.19	280.7	0.25	225.4	0.19	130.5	0.12	144.5
J6	5.6	1.40	269.2	0.14	294.0	0.19	253.5	0.14	150.5	0.12	139.4
J6	15.4	1.24	269.1	0.14	299.0	0.20	255.9	0.13	150.7	0.10	149.5
J6	31.8	1.17	266.3	0.12	299.1	0.18	253.8	0.12	149.4	0.08	153.2

The least squares harmonic analysis directly solves for up to 175 different tidal current constituents, depending on the length of the data set. For the data in this survey, 23 tidal current constituents were computed. Fourier harmonic analysis (29-day) solves for 25 tidal current constituents: eleven tidal current constituents are directly computed, while 14 others are derived using standard amplitude and phase relationships from equilibrium theory.

The M_2 constituent is the major semidiurnal lunar constituent. It is due to the direct tide producing force of the moon and has a period of 12.42 hours. S_2 is the major semidiurnal solar constituent due to the sun; it has a period of 12.00 hours. The interaction of the two constituents going in and out of phase with each other causes the spring/neap cycles.

3.2 St. Johns River Entrance (J1)

Prior to this survey, the St. Johns River Entrance was an NOS Reference Station for only 17 subordinate tidal current stations; the previous predictions at this Reference Station had been based on two 15-day current pole observations collected in 1934. The new data collected at this station are now being used to compute all of the published NOS tidal current predictions in the St. Johns River. Starting with the 1999 edition of the NOS Tidal Current Tables, a total of 55 subordinate tidal current stations (including multiple depths at 20 individual sites) will be referenced to the St. Johns River Entrance station. Appendix B contains the year 2000 tidal current predictions (Table 1 and Table 2) for the St. Johns River. In addition to the new data collected during this survey, there were older, archived data that were previously unpublished. These data were revisited, and where appropriate, they were fully processed and analyzed.

The new Reference Station was deployed approximately 270 yards to the west of the published position of the 1934 station, allowing for a direct inter-comparison of the two data sets. Figure 3.6 is a 16-hour time-series plot comparing the tidal current predictions based on the 1934 data with the tidal current predictions based on the new 1998 data. The most apparent difference between the two sets of predictions is seen in the phase of the currents: all four phases (SBE, MEC, SBF, MFC) of the new tidal current predictions occur earlier than the old tidal current predictions, by as much as almost an hour. Over the past 64 years, there have been numerous bathymetric and hydrological changes in the river, having a pronounced effect on the amplitude and phase of the currents.

The new predicted maximum *flood* speeds are slightly *stronger* than the old predicted maximum flood speeds, while the new predicted maximum *ebb* speeds are slightly *weaker* than the old predicted maximum ebb speeds. The smaller ebb speeds may be a result of the considerable deepening and widening of the river over the past 60-plus years. Currents (especially ebb currents) in a tidal river such as the St. Johns River will generally decrease when the cross-sectional area (depth and width) is increased, assuming the overall discharge stays fairly constant during that time (Pond and Pickard, 1983).

The maximum current speed observed during the 96.0 day measurement period was 3.43 knots toward 264.3 degrees, which is in the flood direction. This speed was measured at a depth of 9.8 feet on May 25, 1998, on the day of a new moon. Figure 3.7 is a velocity scatter diagram of the currents at a depth of 16.4 feet. The effect of the Mayport Basin is clearly seen here during the ebb current; in the northeast quadrant, there is a small divergence of the flow, especially at ebb speeds greater than about 1.5 knots.

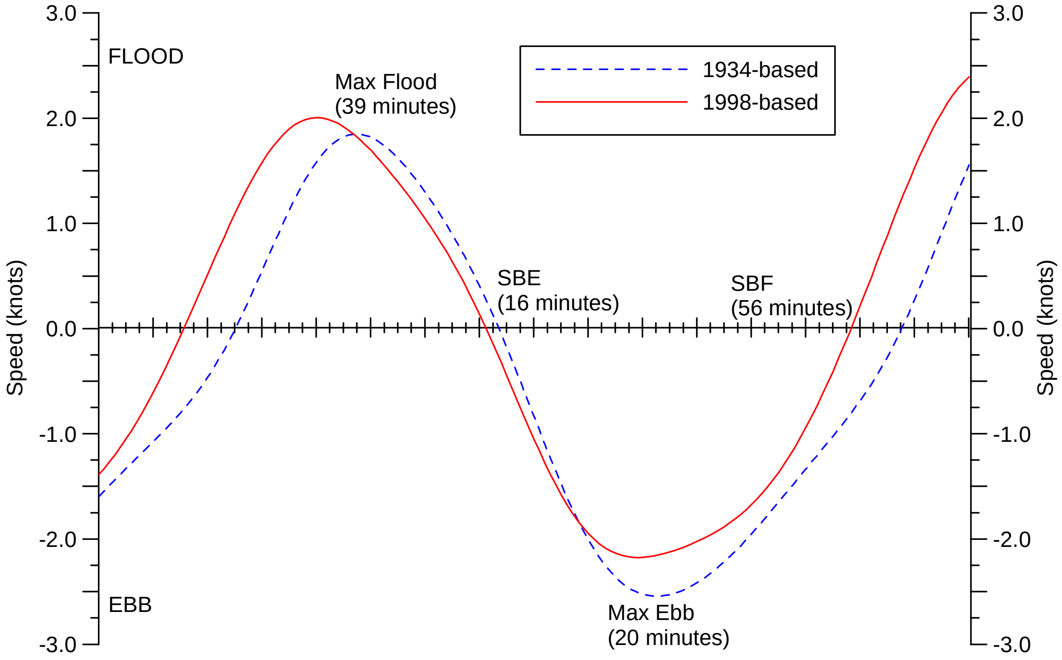

Figure 3.6 Comparison of the 1934-based and the 1998-based tidal current predictions at the River Entrance (J1).

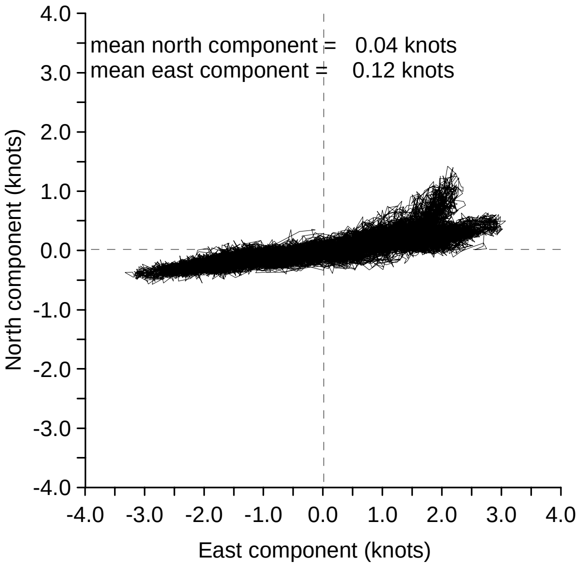

Figure 3.7 Velocity scatter diagram for the River Entrance (J1), 16.4 ft. depth.

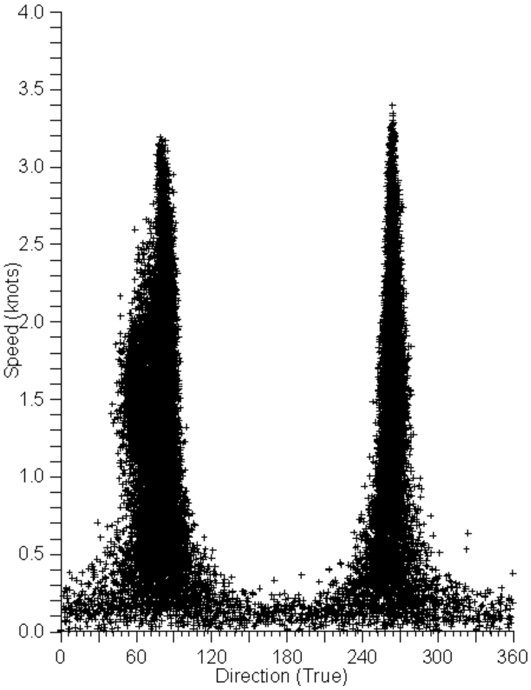

Figure 3.8 Speed-direction scatter plot for the River Entrance (J1), 9.8 ft. depth.

Figure 3.8 is a speed-direction scatter plot of the currents at a depth of 9.8 feet. This is a good illustration of the bipolar, rectilinear nature of the currents in the river. The ebb current (mean direction of 81° True) is not as "tight" as the flood current (mean direction of 262° True), again due to the draining of the Mayport Basin during the stronger ebb flows. The effect of the jetties in this area is to constrict the direction of the current.

A seven-day time-series plot representing the measured currents, astronomical predictions, and residual currents (all along-channel at 16.4 ft. depth) is presented in Figure 3.9. The tidal current constituents, obtained by least-squares harmonic analysis, were used to predict the tidal current for the 96.0-day measurement period. These values were then subtracted from the observed current to obtain the residual current.

Analysis of the residual current at the 16.4 ft. depth reveals that the standard deviation for the measurement period is 0.23 knots. The standard deviation is a direct measure of the observed variability in a time-series. When applied to the residual current, it is a good method to gage the proportion of nontidal energy in the total current. The astronomical constituents accounted for more than 97% of the total variance, with the M_2 constituent comprising over 90% of the total variance alone. The remaining 3% of the variance is due to meteorological and hydrological forces, such as weather fronts, offshore events, and streamflow. Results for the other depths are similar.

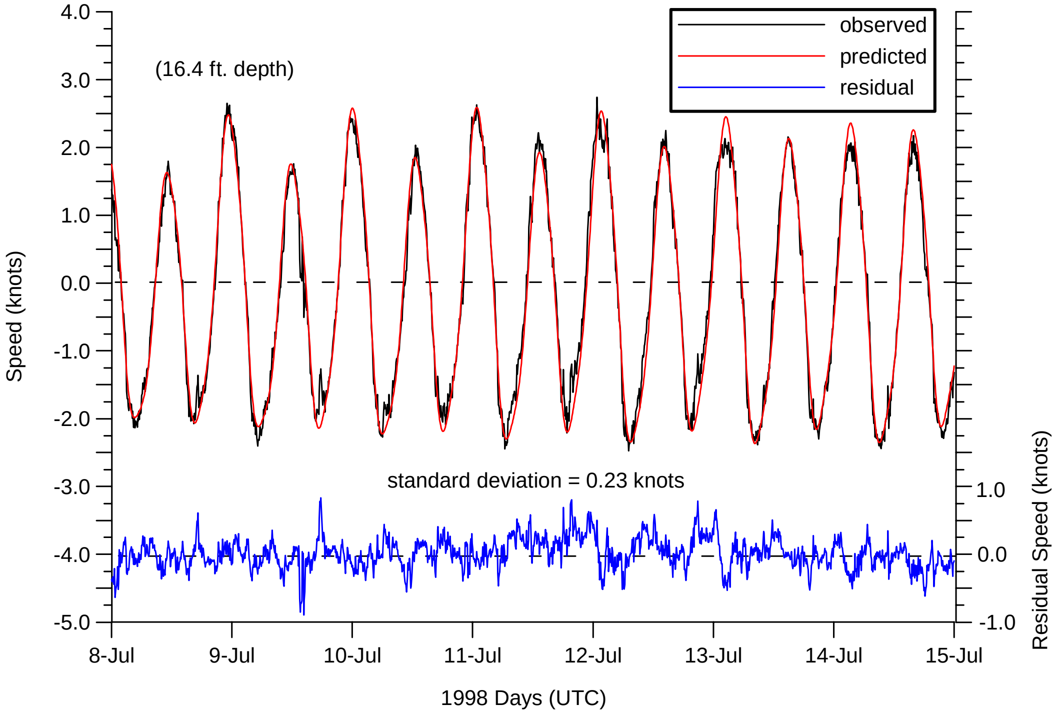

Figure 3.9 Observed, predicted, and residual current (along-channel--262°) at the River Entrance (J1) during a seven day period. Note that the residual standard deviation value is for the entire 96.0-day deployment period.

3.3 Mayport Basin Entrance (J2)

The Mayport Basin Entrance is a new station for NOS, so there are no prior data at this site to make comparisons. A seven-day time-series plot representing the measured currents, astronomical predictions, and residual currents (all along-channel at 15.1 ft. depth) is presented in Figure 3.10. The tidal current constituents were obtained by least-squares harmonic analysis, and used to compute the astronomical tidal current for the 48.0-day measurement period. These values were then subtracted from the observed current to obtain the residual current. This procedure was performed on data at three different depths: 8.5 ft., 15.1 ft., and 31.5 ft.

Analysis of the residual current at the 15.1 ft. depth reveals that the standard deviation for the measurement period is 0.19 knots. The astronomical constituents account for 96% of the total variance, with the M_2 constituent comprising over 90% of the total variance alone. The remaining 4% of the variance is due to meteorological and hydrological forces. Results for the other depths are similar.

The maximum current speed observed during the measurement period was 2.53 knots toward 103.4 degrees, which is in the ebb direction. This speed was measured at a depth of 5.2 feet on June 10, 1998, on the day of a full moon. The current in the upper five to 12 feet of the water column exhibits a significant cross-channel flow, cutting across the Mayport channel axis at about a 25° to 30° angle, especially during ebbing currents greater than about 1.8 knots (Figure 3.11). In fact, the vast majority of the strongest currents (from 1.8 knots to 2.2 knots) observed at this station occurred in the upper five to 12 feet, during ebb flow, at angles across the main channel.

The current below about 12 feet showed some cross-channel flow during ebb conditions, but not to the same extent as the surface water. The ebb current strength decreased with depth, and the angle of the cross-channel flow was not as extreme towards the deeper sections. The strongest currents below 12 feet were from about 1.4 knots to 1.7 knots, mostly in a flood direction, in-line with the channel.

Figure 3.12 is a speed-direction scatter plot of the currents at a depth of 8.5 feet; it illustrates the relative flood and ebb distribution. This figure shows that the ebb current (mean direction of 93° True) is slightly stronger than the flood current (mean direction of 255° True), and that the two axes are 162° apart, owing to the cross-channel flow at this depth.

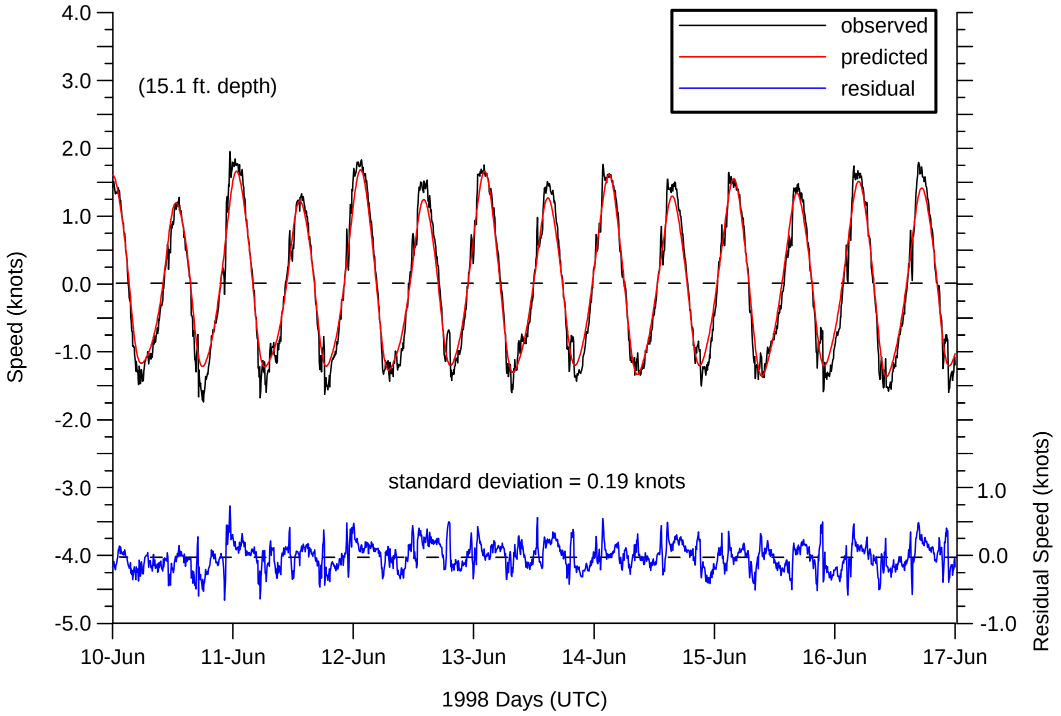

Figure 3.10 Observed, predicted, and residual current (along-channel--259°) at Mayport Basin Entrance (J2) during a seven day period. Note that the residual standard deviation value is for the entire 48.0-day deployment period.

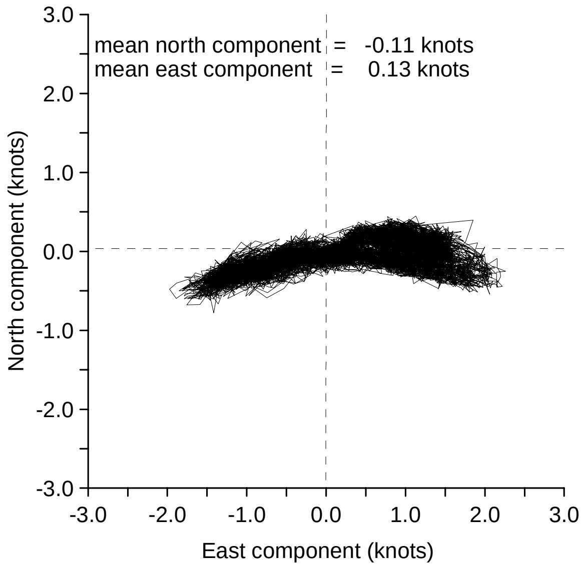

Figure 3.11 Velocity scatter diagram for Mayport Basin Entr. (J2), 8.5 ft. depth.

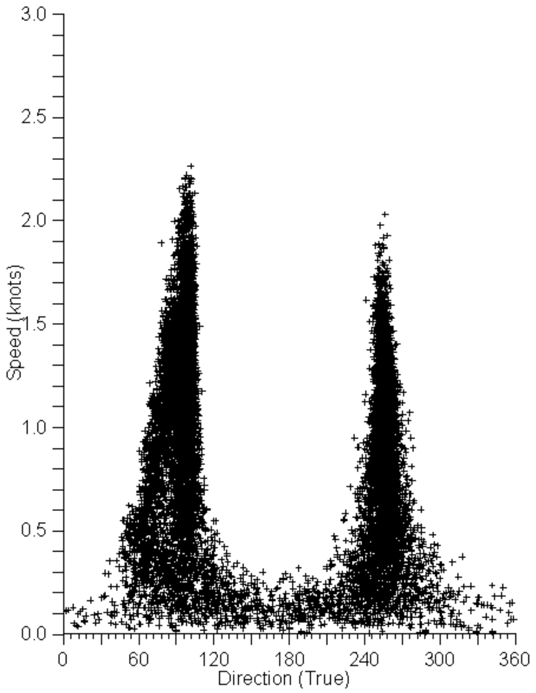

Figure 3.12 Speed-dir. scatter plot for Mayport Basin Entr. (J2), 8.5 ft. depth.

3.4 Inner Mayport Basin (J3)

Figure 3.13 is a velocity scatter diagram of the currents at a depth of 5.9 feet, and Figure 3.14 is a speed-direction scatter plot of the currents at a depth of 9.2 feet. Both figures clearly show the extremely slow currents measured at this station. These weak currents were most likely a result of the current meter's position–it was placed too close to the south side of the basin, very near the Naval pier known as "foxtrot" pier. If the station had been positioned just 100 yards to the north, the measured currents most likely would have been more substantial. Because of the very low observed currents at this station, the data were considered unusable, and no harmonic analyses were performed or astronomical predictions computed. The NOS standard is that any current less than 1/4 knot is considered weak and variable.

The maximum current speed observed during the measurement period was 0.91 knots toward 247.0 degrees, which is in the flood direction. This speed was measured at a depth of 5.9 feet on June 10, 1998, on the day of a full moon. However, it was an anomalous value; less than 10% of the measurements at this depth exceeded 1/2 knot. All other depths showed even slower speeds: as the depth increased, the observed current decreased markedly. The current at 9.2 feet exceeded 1/2 knot only <u>eight times</u> out of the more than 11,000 six-minute observations, and exceeded 1/4 knot only 13% of the 48.3-day measurement period.

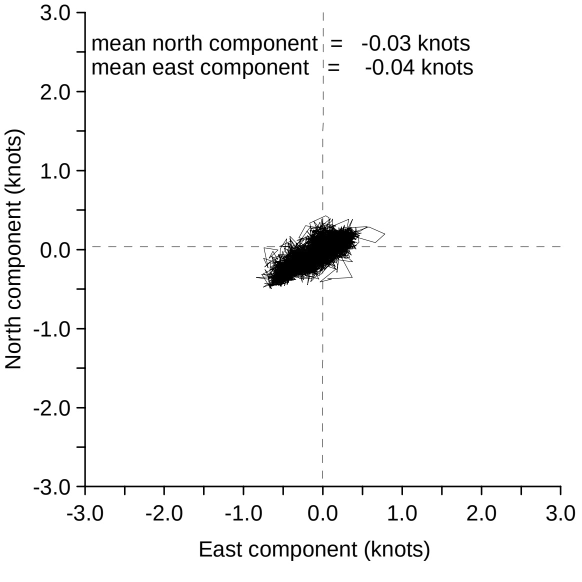

Figure 3.13 Velocity scatter diagram for Inner Mayport Basin (J3), 5.9 ft. depth.

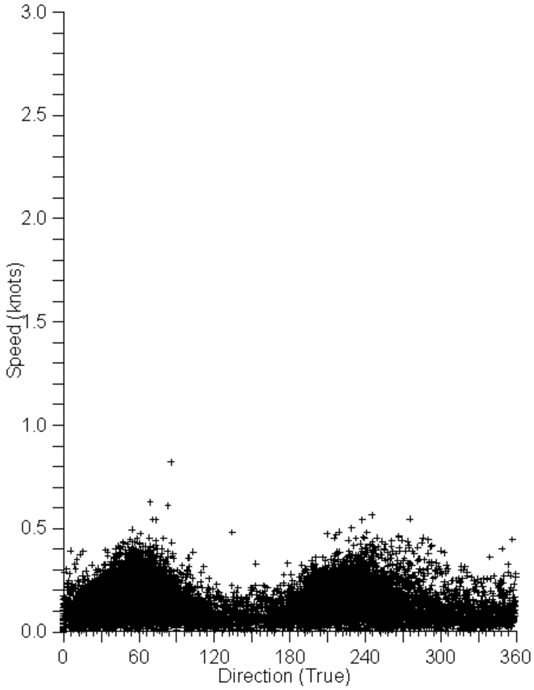

Figure 3.14 Speed-Dir. scatter plot for Inner Mayport Basin (J3), 9.2 ft. depth.

3.5 Intracoastal Waterway Intersection (J4)

The Intracoastal Waterway (ICW) Intersection is a new station for NOS, so there are no prior data at this site to make comparisons. A seven-day time-series plot representing the measured currents, astronomical predictions, and residual currents (all along-channel at 16.1 ft. depth) is presented in Figure 3.15. The tidal current constituents were obtained by least-squares harmonic analysis, and used to compute the astronomical tidal current for the 49.8-day measurement period. These values were then subtracted from the observed current to obtain the residual current. This procedure was performed on data at three different depths: 9.5 ft., 16.1 ft., and 29.2 ft.

Analysis of the residual current at the 16.1 ft. depth reveals that the standard deviation for the measurement period is 0.25 knots. The astronomical constituents account for more than 97% of the total variance, with the M_2 constituent comprising almost 90% of the total variance alone. The remaining 3% of the variance is due to meteorological and hydrological forces. Results for the other depths are similar.

The ICW crosses the main channel of the St. Johns River at about a 45° angle from the north; while, from the south, it enters almost parallel to the main channel. Because of the influence of the ICW, the current in the upper six to 23 feet of the water column exhibits a significant cross-channel flow, mainly early in the ebb cycle, when the current is between about 0.5 knots to 1.3 knots. During these conditions, the water from the ICW (flowing out from the south) causes a cross-channel flow at about 30° to 40° across the main channel (Figure 3.16). When the ebbing current in the upper 23 feet becomes greater than about 1.5 knots, the direction of the flow comes in-line with the main channel. The current below about 23 ft. depth showed some cross-channel flow, but not nearly to the same extent as the surface water.

The maximum current speed observed during the measurement period was 3.79 knots toward 132.6 degrees, which is in the ebb direction. This speed was measured at a depth of 6.2 feet on April 27, 1998, one day after a new moon. The flood currents are significantly weaker than the ebb currents at this station: at 9.5 ft., the maximum flood currents (mean direction of 293° True) average only 1.6 knots, while the maximum ebb currents (mean direction of 125° True) average 2.6 knots (Figure 3.17). Also, at 16.1 ft., the maximum flood currents average only 1.6 knots, while the maximum ebb currents average 2.4 knots.

In the upper 23 ft., the current at this station rotates clockwise during a given tidal cycle; the ebb current will start flowing toward about 80° to 90° until the speed reaches about 1.3 knots to 1.5 knots, when the direction of the current will rapidly change to about 120° to 130°, in-line with the main channel. The current then remains in this state, slows to a minimum current, then quickly turns to a flood toward about 300°. Because of the influence of the ICW, the slack-before-ebb at this station is relatively high; it is usually greater than 1/3 knot, while the slack-before-flood is almost always less than 1/4 knot.

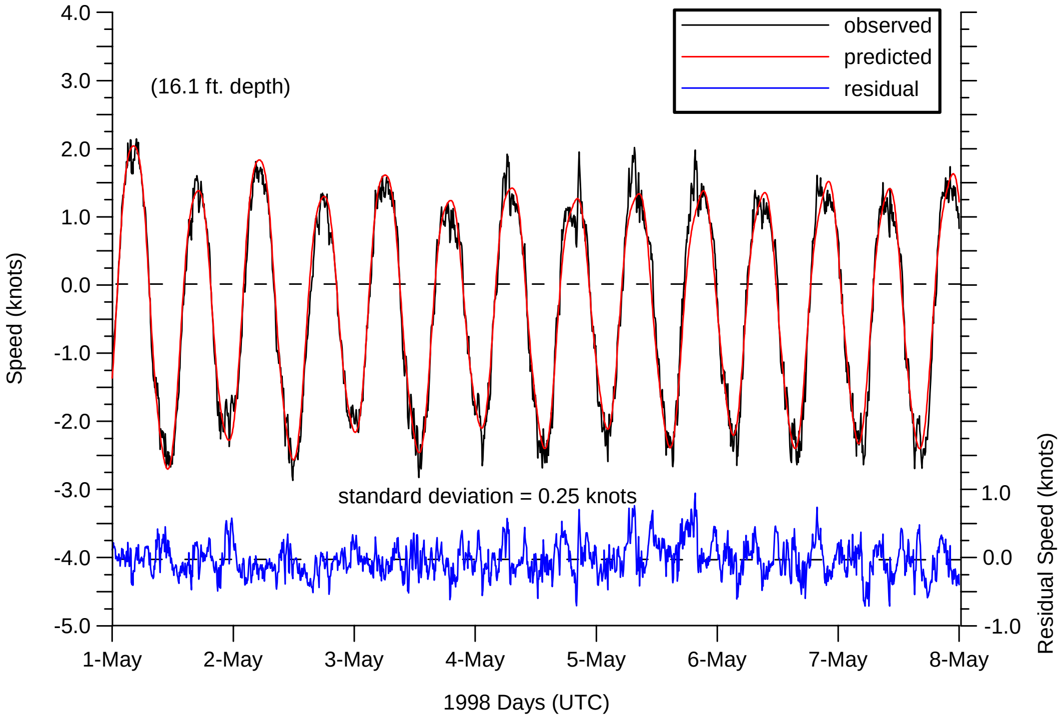

Figure 3.15 Observed, predicted, and residual current (along-channel--293°) at the I.C.W. Intersection (J4) during a seven day period. Note that the residual standard deviation value is for the entire 49.8-day deployment period.

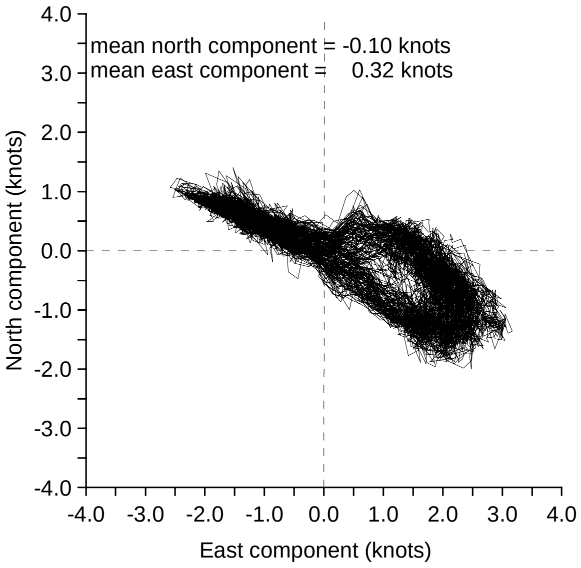

Figure 3.16 Velocity scatter diagram for I.C.W. Intersection (J4), 16.1 ft. depth.

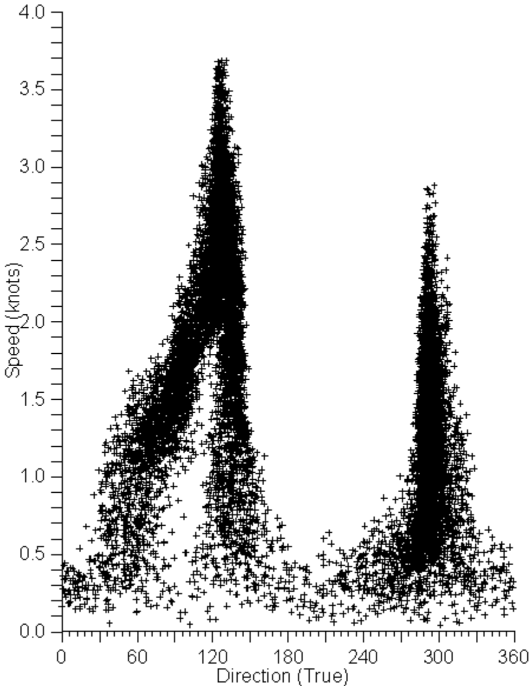

Figure 3.17 Speed-Dir. scatter plot for I.C.W. Intersection (J4), 9.5 ft. depth.

3.6 East Blount Island (J7)

East Blount Island is a new station for NOS, so there are no prior data at this site to make comparisons. A seven-day time-series plot representing the measured currents, astronomical predictions, and residual currents (all along-channel at 16.4 ft. depth) is presented in Figure 3.18. The tidal current constituents were obtained by least-squares harmonic analysis, and used to compute the astronomical tidal current for the 54.0-day measurement period. These values were then subtracted from the observed current to obtain the residual current. This procedure was performed on data at three different depths: 6.6 ft., 16.4 ft., and 29.5 ft. Analysis of the residual current at the 16.4 ft. depth reveals that the standard deviation for the measurement period is 0.25 knots. The astronomical constituents account for almost 96% of the total variance, with the M_2 constituent comprising 90% of the total variance alone. The remaining 4% of the variance is due to meteorological and hydrological forces. Results for the other depths are similar.

The maximum current speed observed during the measurement period was 3.36 knots toward 72.5 degrees, which is in the ebb direction. This speed was measured at a depth of 6.6 feet on September 8, 1998, two days after a full moon. The station was located in the center of the navigation channel, on the east end of the Dames Point-Fulton Cutoff, about 130 yards due south of the breakwater light #36. Here, the main channel makes a slight turn (~25°). This area is a confluence of three sources of flow: the main shipping channel (Dames Point-Fulton Cutoff), the natural St. Johns River (flowing north of Blount Island), and the Back River. Even with the three sources of water in this area, the current exhibited only a slight cross-channel flow, and only in the upper 16 feet (Figure 3.19).

The current at this station rotates counter-clockwise during a given tidal cycle. In the upper 16 ft., the ebb current will start flowing toward about 120° (influenced by the flow from the Back River and the natural St. Johns River, until the speed reaches about one knot, when the direction of the current changes to about 80°, in-line with the main shipping channel. The current remains in this direction, slows to a minimum current, then quickly turns counter-clockwise to a flood, toward about 270°.

The flood currents are significantly weaker than the ebb currents at this station, especially in the upper 16 feet. At 6.6 ft., the maximum flood currents (mean direction of 275° True) average only 1.5 knots, while the maximum ebb currents (mean direction of 79° True) average 2.3 knots (Figure 3.20). Also, at 16.4 ft., the maximum flood currents average 1.4 knots, while the maximum ebb currents average 1.7 knots. Below about 20 feet, the average maximum flood and ebb currents are almost equal, at approximately 1 1/4 to 1 1/2 knots.

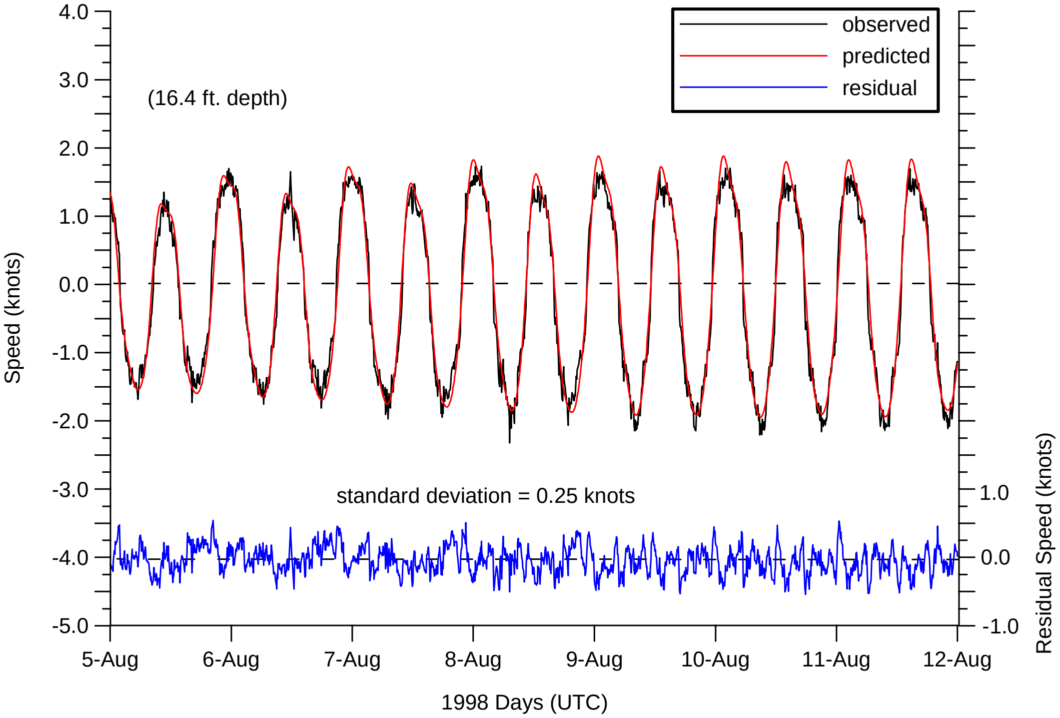

Figure 3.18 Observed, predicted, and residual current (along-channel–270°) at East Blount Island (J7) during a seven day period. Note that the residual standard deviation value is for the entire 54.0-day deployment period.

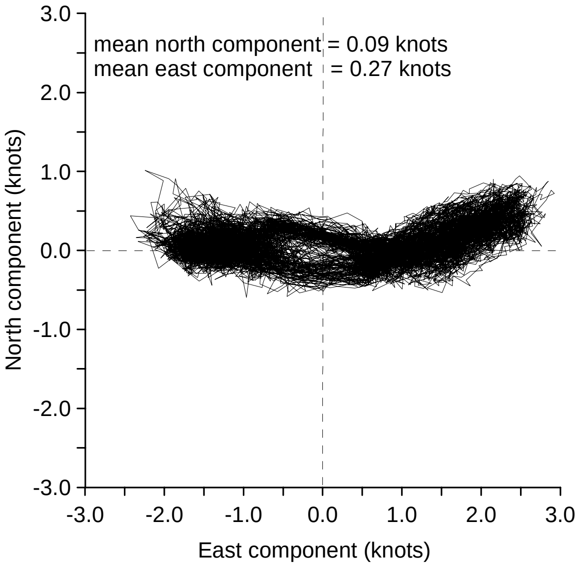

Figure 3.19 Velocity scatter diagram for East Blount Island (J7), 9.8 ft. depth.

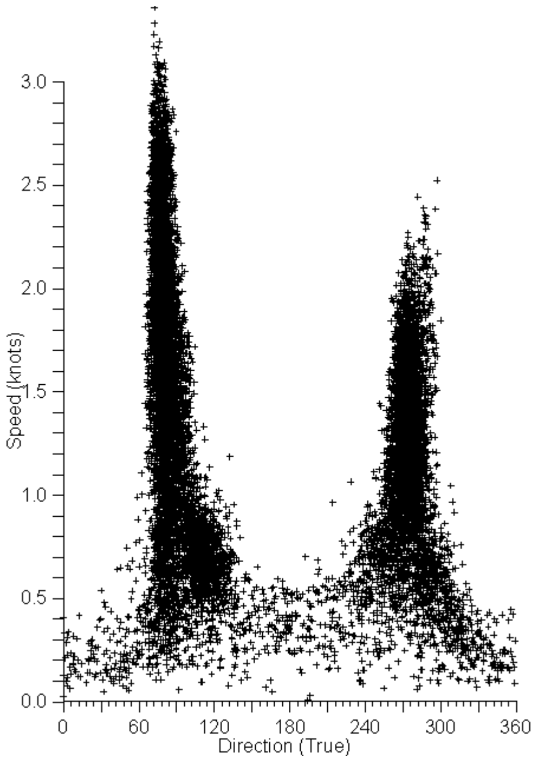

Figure 3.20 Speed-Dir. scatter plot for East Blount Island (J7), 6.6 ft. depth.

3.7 Dames Point Bridge (J5)

Dames Point Bridge is a new station for NOS, so there are no prior data at this site to make comparisons. A seven-day time-series plot representing the measured currents, astronomical predictions, and residual currents (all along-channel at 14.4 ft. depth) is presented in Figure 3.21. The tidal current constituents were obtained by 15-day Fourier harmonic analysis, and used to compute the astronomical tidal current for the 22.6-day measurement period. These values were then subtracted from the observed current to obtain the residual current. This procedure was performed on data at three different depths: 4.6 ft., 14.4 ft., and 27.6 ft. Analysis of the residual current at the 14.4 ft. depth reveals that the standard deviation for the measurement period is 0.28 knots.

Only 22.6 days of data were collected at this station, so a 15-day Fourier harmonic analysis was performed, as opposed to a 29-day Fourier harmonic analysis or a least-squares harmonic analysis. The main difference in the 15-day Fourier harmonic analysis is that the N_2 tidal constituent is inferred from the M_2 tidal constituent, and 14 other tidal constituents are inferred (from equilibrium theory) rather than computed directly as with the least-squares harmonic analysis. This explains the highest prediction error (based on the residual standard deviation) of any of the stations in this survey.

The maximum current speed observed at this station during the measurement period was 2.56 knots toward 85.1 degrees, which is in the ebb direction. This speed was measured at a depth of 4.6 feet on July 25, 1998, two days after a new moon. The station was located in the center of the navigation channel, on the west end of the Dames Point-Fulton Cutoff, about 200 yards due east of the Dames Point bridge. Here, the Blount Island channel enters the main shipping channel from the north. Even with this confluence, the current exhibited only a slight cross-channel flow, and only in the upper 14 feet, late in the flood cycle (Figure 3.22).

In the upper 14 ft., the current rotates counter-clockwise during a given tidal cycle; the ebb current will start flowing toward about 70° to 80°, in-line with the main shipping channel. The current remains in this direction, slows to a minimum current, then turns counter-clockwise to a flood, toward about 280°. The flood direction remains at about 280°, until late in the flood cycle, when the current slows to less than one knot. The current then turns to about 230° to 260°, being influenced by the inflowing water of the Blount Island channel to the north.

The flood currents are significantly weaker than the ebb currents at this station. At 4.6 ft., the maximum flood currents (mean direction of 254° True) average only 1.2 knots, while the maximum ebb currents (mean direction of 80° True) average 1.9 knots (Figure 3.23). Also, at 14.4 ft., the maximum flood currents average 1.4 knots, while the maximum ebb currents average 1.8 knots.

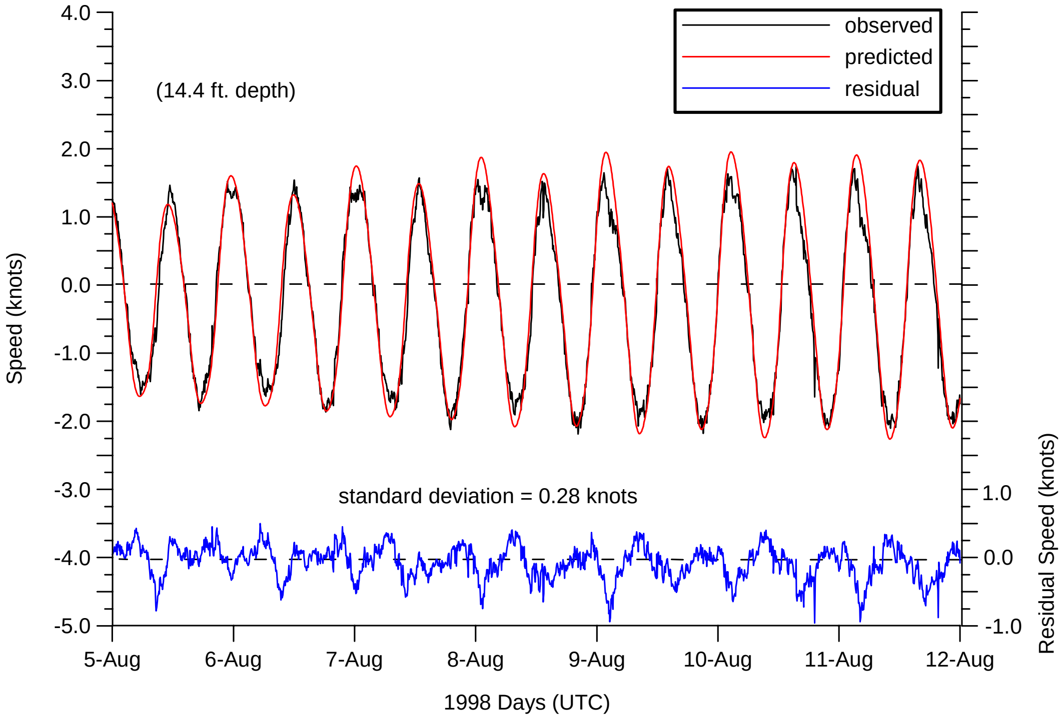

Figure 3.21 Observed, predicted, and residual current (along-channel–257°) at Dames Point Bridge (J5) during a seven day period. Note that the residual standard deviation value is for the entire 22.6-day deployment period.

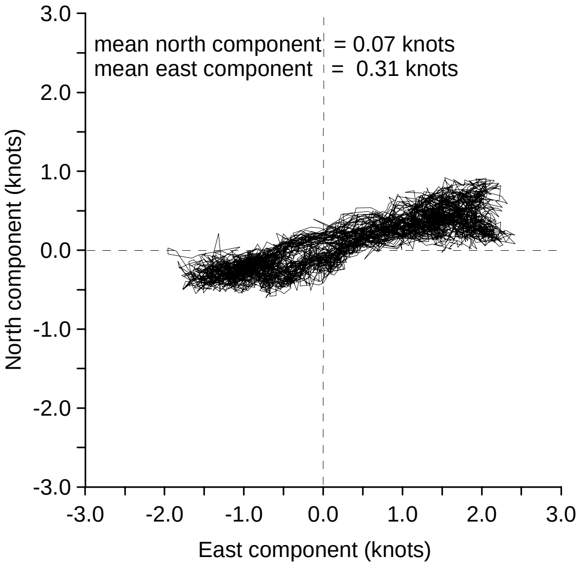

Figure 3.22 Velocity scatter diagram for Dames Point Bridge (J5), 7.9 ft. depth.

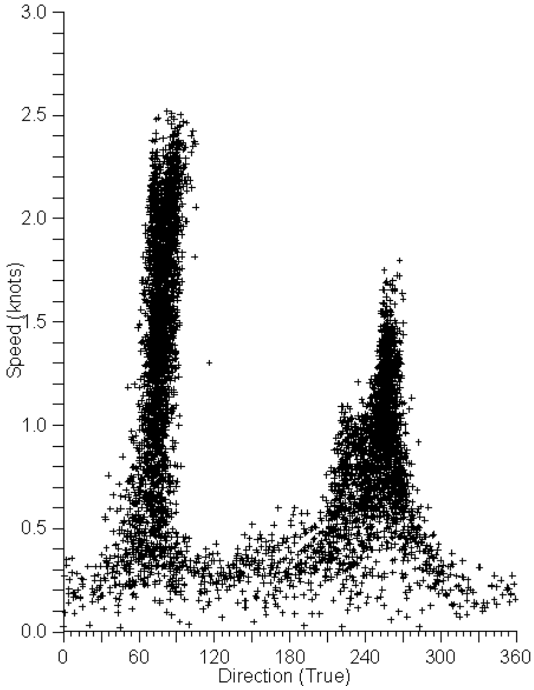

Figure 3.23 Speed-Dir. scatter plot for Dames Point Bridge (J5), 4.6 ft. depth.

3.8 Trout River Cut (J6)

Prior to this survey, the Trout River Cut station was known as "Phoenix Park." This was an NOS subordinate station, based on the St. Johns River Entrance reference station. The previous predictions at this station had been based on five days of observations collected in 1958. The new data collected at this station are now being used in the NOS Tidal Current Tables (Appendix B). The new current meter at this site was located about 240 yards to the north of the published position of the 1958 station, so, a direct inter-comparison of the two data sets is possible.

Figure 3.24 is a 16-hour time-series plot comparing the tidal current predictions based on the 1958 data and the new 1998 data. The most apparent difference between the two sets of predictions is seen in the phase of the currents: all four phases (SBE, MEC, SBF, MFC) of the new tidal current predictions occur earlier than the old tidal current predictions, from at least a half-hour to as much as an hour. The new predicted maximum *flood* speeds are about the same as the old predicted maximum flood speeds, while the new predicted maximum *ebb* speeds are *stronger* than the old predicted maximum ebb by about 25%. As with the St. Johns River Entrance station, numerous bathymetric and hydrological changes have occurred in this area over the past 40 years, causing changes to the amplitude and phase of the currents.

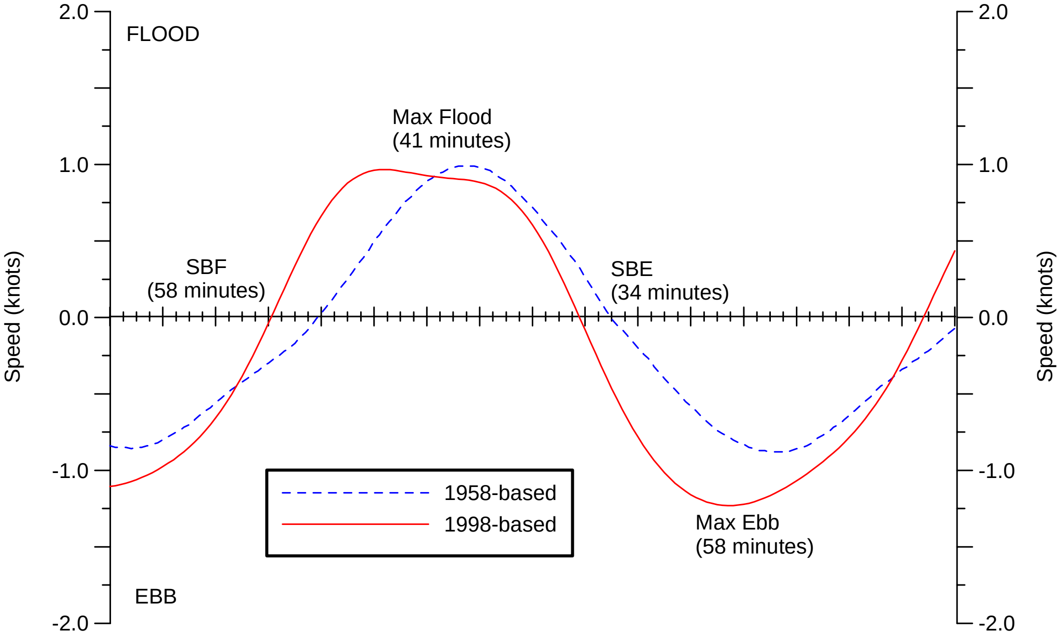

Figure 3.24 Comparison of the 1958-based and the 1998-based tidal current predictions at Trout River Cut (J6).

A seven-day time-series plot representing the measured currents, astronomical predictions, and residual currents (all along-channel at 15.4 ft. depth) is presented in Figure 3.25. The tidal current constituents, obtained by least-squares harmonic analysis, were used to predict the tidal current for the 55.5-day measurement period. These values were then subtracted from the observed current to obtain the residual current.

Analysis of the residual current at the 15.4 ft. depth reveals that the standard deviation for the measurement period is 0.19 knots. The astronomical constituents account for almost 96% of the total variance, with the M_2 constituent comprising more than 90% of the total variance alone. The remaining 4% of the variance is due to meteorological and hydrological forces. Results for the other depths are similar.

The station was located in the center of the navigation channel, on the south end of the Trout River Cut Range, about 150 yards from the navigational buoys “67" and “68". Here, the Trout River enters the main shipping channel from the west. The current at this station generally did not exhibit any cross-channel flow, even with the proximity of the Trout River. This may have been a function of the particular position of the instrument. Had the station been positioned further to the north, there may have been a significant cross-channel flow observed.

The maximum current speed observed during the 55.5-day measurement period was 2.18 knots toward 15.4 degrees, which is in the ebb direction. This speed was measured at a depth of 8.9 feet on September 8, 1998, two days after a full moon. Figure 3.26 is a velocity scatter diagram of the currents at a depth of 8.9 feet. It shows that, overall, the flood currents are slightly weaker than the ebb currents at this station, and there is little cross-channel flow.

Figure 3.27 is a speed-direction scatter plot of the currents at a depth of 5.6 feet. This again illustrates the rectilinear nature of the currents at this station. At 5.6 ft., the maximum flood currents (mean direction of 193° True) average 1.3 knots, while the maximum ebb currents (mean direction of 005° True) average 1.5 knots. Also, at 15.4 ft., the maximum flood currents average 1.1 knots, while the maximum ebb currents average 1.3 knots (Appendix B).

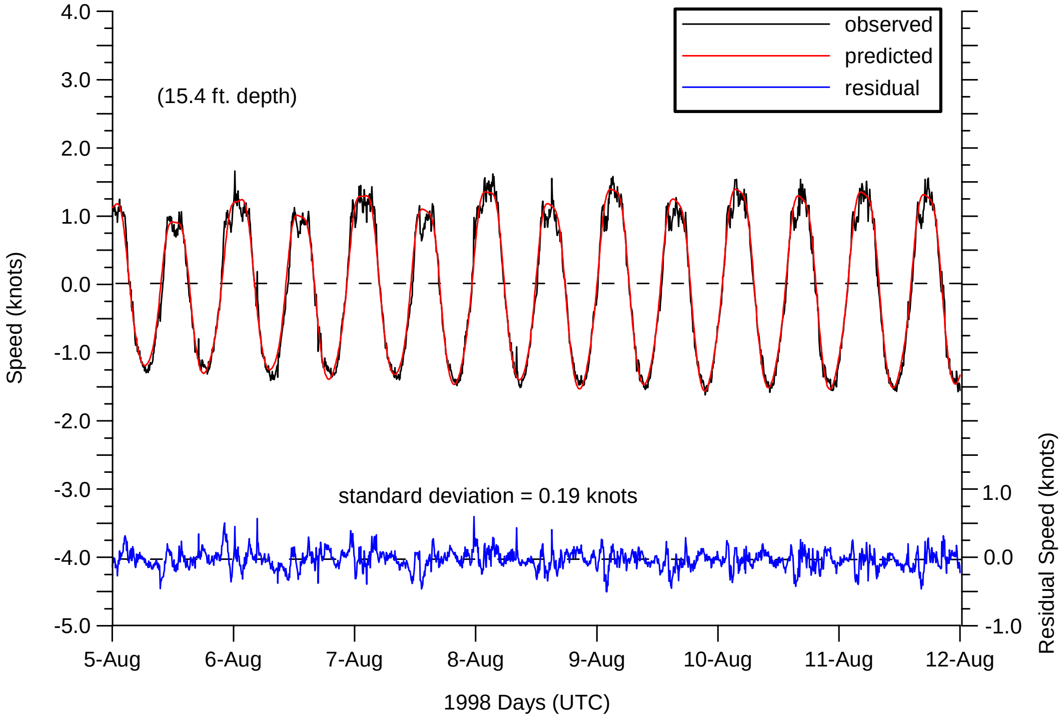

Figure 3.25 Observed, predicted, and residual current (along-channel–191°) at Trout River Cut (J6) during a seven day period. Note that the residual standard deviation value is for the entire 55.5-day deployment period.

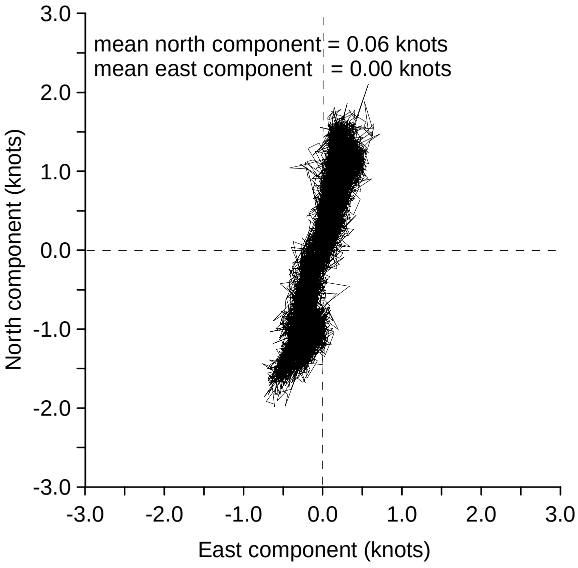

Figure 3.26 Velocity scatter diagram for Trout River Cut (J6), 8.9 ft. depth.

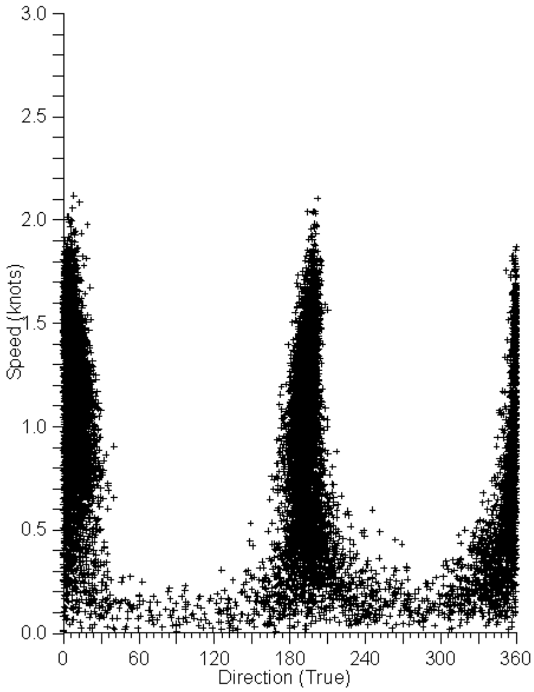

Figure 3.27 Speed-Dir. scatter plot for Trout River Cut (J6), 5.6 ft. depth.

4. RESPONSE OF THE CURRENTS AND WATER LEVELS TO A STORM EVENT

Prevailing winds in the lower St. Johns River basin are northeasterly in the fall and winter months, and southwesterly in spring and summer. The strongest winds generally occur in February and March, while lighter winds generally occur in July and August. The greatest rainfall, mostly in the form of local thundershowers, occurs during the summer months in the lower SJR basin. Rainfall of 1 inch or more in 24 hours normally occurs about fourteen times a year, and very infrequently heavy rains, associated with tropical storms, reach amounts of several inches with durations of more than 24 hours. Winter is the dry season, having the least rainfall. River flow is seasonal, generally following the seasonal rain patterns, with higher flows occurring in the late summer to early fall, and the lower flows occurring in the winter months (NOAA, 1998).

Throughout the lower St. Johns River, more than 80% of the total river flow is attributed to tidal forces (NOAA, 1985). However, during storm events, the tides can be overcome by nontidal factors such as wind, rain, and streamflow. Persistent winds from the north will cause a marked elevation of the water levels, a significant increase of the flood current speeds, and lengthening of the flood current duration. Winds from the south will have the opposite effect. Wind setup occurs at sustained wind speeds of greater than about 7 knots.

From August 2-4, a persistent wind blew from the north at 10-15 knots for more than 48 hours, gusting consistently near 20 knots (Figure 4.1). While not an extreme storm, the persistent direction and speed of the wind caused a significant setup in the water levels and affected the currents substantially (Figure 4.2, panels A and B).

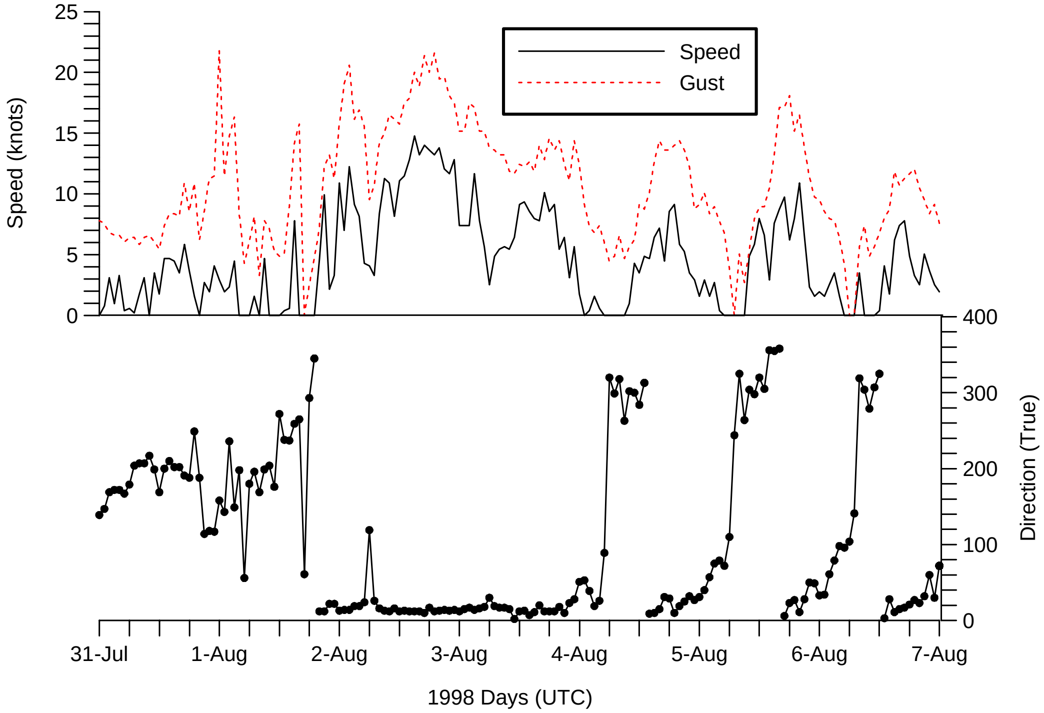

Figure 4.1 Wind speed, gust, and direction at Mayport during an early August 1998 storm event. Note that the wind direction is the direction the wind is from.

In addition to the steady wind, there was significant rainfall associated with this storm. This is reflected in the streamflow from a USGS gaging station in Pablo Creek, just south of the SJR, near Mayport (Figure 4.2, panel C). It shows that a sharp rise in the streamflow occurred in less than eight hours, late on August 1, peaking at over 530 cfs. This turned out to be the annual peak at this gaging station for 1998. The mean daily flow for this station is approximately 50 cfs.

Prior to the storm, the observed water levels throughout the lower SJR were all running at or just under predicted tides. The observed water levels at Dames Point were lower than the predicted tide by about 0.1 ft. to 1 ft. (Figure 4.2, panel A). Late on August 1, the water level began responding to the persistent northerly winds and increased streamflow, and rose to about 1 ft. over the predicted tide. The water levels continued in this state for about 2 1/2 days, until late on August 4, when they began to slowly fall back down in line with the predicted tide.

Observed currents at the two operating current meters (Trout River and East Blount Island) were in good agreement with tidal current predictions, prior to the storm. Late on August 1, the observed current at East Blount Island began responding to the persistent northerly winds (Figure 4.2, panel B). The ebb current speeds were reduced by as much as 3/4 knot, while the ebb current duration was reduced by about 1 1/2 hours. The flood current speeds were increased by as much as 1 knot, while the flood current duration was increased by about 1 1/2 to 2 hours. The currents at this station were affected for about 1 1/2 days, until mid-day on August 3, when they quickly returned back to a normal tidal state.

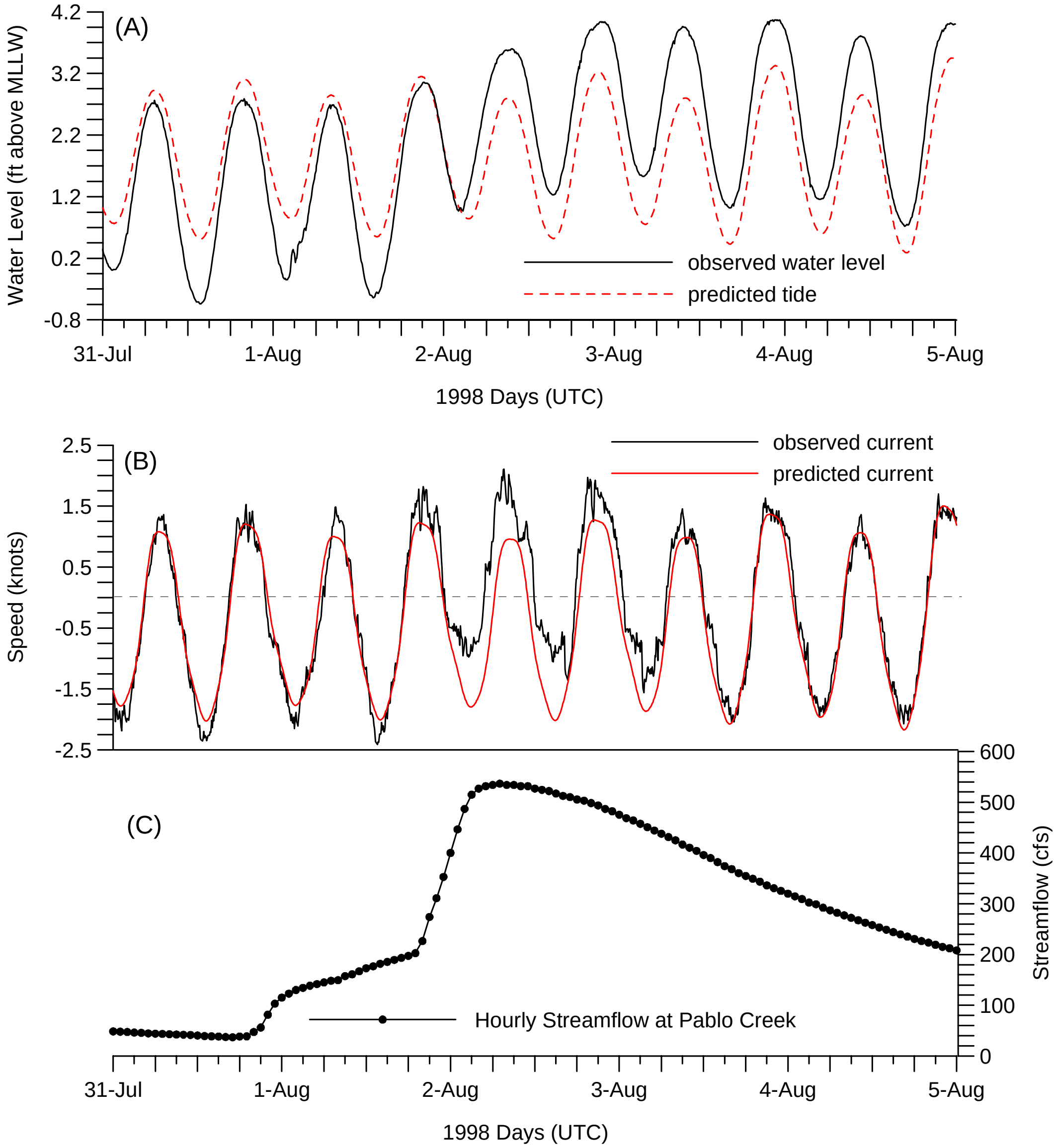

Figure 4.2 Observed water level, and predicted tides at Dames Point (Panel A), observed and predicted current (6.6 ft.) at East Blount Island (Panel B), and streamflow at Pablo Creek (Panel C) during an early August 1998 storm event.

5. SUMMARY

The National Ocean Service's Center for Operational Oceanographic Products and Services conducted an oceanographic survey of the currents in the St. Johns River, Florida from mid April to mid September, 1998. The main goal of this survey was to collect new measurements of the currents in as many sites as feasible in the St. Johns River to update the published tidal current predictions. New measurements of the currents in the St. Johns River had not been collected since surveys in the 1930s and 1950s. Over the decades, the currents have been affected by extensive dredging of channels, new harbor and channel construction, and other natural and man-made modifications. The large military presence and shipping industry in the St. Johns River require that accurate tidal current predictions be available.

From the river's entrance near the Mayport Naval Station to the Trout River Cut, seven new current meter stations were occupied throughout a sixteen-mile stretch of river, where the local community expressed a need for more accurate information. The results of this survey have led to the generation of new, more accurate tidal current predictions, which will serve to increase the safety and efficiency of navigation and commerce in the SJR system. Because of this survey, 18 new tidal current prediction stations (six stations with three depths each) were added to the Tidal Current Tables, and 23 historical stations (twelve stations with one or two depths each) were validated, and incorporated into the Tidal Current Tables (Appendix B).

Currents in the lower St. Johns River are tidally dominated; they are semidiurnal, consisting of two flood and two ebb periods each day. Because the river is basically a constricted channel, the currents are rectilinear, and exhibit mostly progressive wave characteristics. This relationship varies along the river, depending on the distance from the mouth of the river, the water depth, and other physical factors. At the river entrance, the maximum flood and ebb currents occur approximately one hour before the high and low tides at the river entrance. Further upriver, at Dames Point (approximately 10.5 miles from the river entrance), the maximum flood and ebb currents precede the times of high and low water by only about 15-35 minutes. Somewhere around 15 to 17 miles from the river entrance, the flood and ebb strengths occur almost simultaneously with the times of high and low waters.

The progression of the tidal current from the mouth of the river to the Trout River Cut is highly linear. In this approximately 16-mile stretch of river, there was a measured time difference of 2.3 to 2.9 hours for all four phases of the tidal current. This corresponds to an average progression speed of about 5.5 to 7.0 knots, which is important information to mariners when planning for the most efficient times to transit up or down the river. This linear relationship of the tidal current phases along the river was also used as a tool to verify older tidal current prediction stations, prior to publishing the latest tidal current predictions.

The currents at all of the stations exhibited vertical profiles that are typical of tidal rivers. Current speeds were strongest near the surface and decreased with depth, due to bottom frictional effects. Down-river stations generally had stronger currents than up-river stations. The highest current speed measured during this survey was a 3.79 knot ebb flow at the ICW Intersection, at a depth of 6.2 feet on April 27, 1998, one day after a new moon.

Harmonic analysis was performed on six of the stations at three different depths each. The most significant astronomical tidal constituent at all of the stations is the semidiurnal lunar constituent, M_2. This tidal constituent accounted for approximately 90% of the total variance in the observed currents at all six stations. Tidal current predictions were computed (using the astronomical tidal current constituents) for six of the stations. Analysis of the residual currents (nontidal current) revealed that between 93% and 99% of the observed currents were tidally-driven.

Although concern was expressed about cross-channel flows at most locations, only the instrument at the Intracoastal Waterway Intersection actually measured a significant cross-channel flow. Other stations exhibited some cross-channel flow, but not to the same extent as the ICW station. During storm events, the tides and tidal currents can be overcome by nontidal factors such as wind, rain, and streamflow. Persistent winds from the north will cause a marked elevation of the water levels, a significant increase of the flood current speeds, and lengthening of the flood current duration. During these conditions, astronomical tide and tidal current predictions are of limited value; real-time information would be much more useful.

The installation of a Physical Oceanographic Real-Time System (PORTS) may be a valuable tool for the local maritime community. PORTS is a decision support tool which improves the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts, and other geospatial information. PORTS collects and disseminates observations and predictions of water levels, currents, air and water temperature, salinity, and meteorological parameters (winds, atmospheric pressure, visibility, etc.). Although PORTS has been developed by NOS, the funding for installation and operation of a PORTS remains the responsibility of the local maritime community (NOS, 1999b).

6. DATA AND INFORMATION PRODUCTS

The data collected from this survey are fully archived and available to the public from the National Ocean Service. To obtain any portion or the complete data set, use the following addresses:

Center for Operational Oceanographic Products and Services
Products and Services Division
N/OPS3
1305 East-West Highway
Silver Spring, MD 20910
(301) 713-2877

e-mail address: **ipss@ceob.nos.noaa.gov**

INTERNET address: **http://www.co-ops.nos.noaa.gov**

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The tug captains and their crews deserve special recognition for their operational support. Captains Pete Coradi and Pat Winn operated the tugs, and showed much professionalism, alertness, and patience, especially when unexpected equipment problems were encountered. Harbor Operations Officer, LCDR Christofferson, and Mr. Bob Reeder, Surface Coordinator, provided logistical support for all of the tug operations.

Dive support was provided by Mr. Rodney Jones on two occasions. He also assisted with line handling during a couple of the instrument deployment and recovery operations. In addition, special gratitude is expressed to Messrs. Gary Collins and Phillip Murphy of the EPA, District 4 for gearing up (with only 1 hours notice) and successfully diving for, and recovering, a critical component of one of our stations.

NOAA employees, Messrs. Richard Bourgerie and Jim Lewis were field party chiefs. Mr. Peter Stone and Mrs. Karen Earwaker provided additional field support and constructive comments on the content of this report. The draft technical report was reviewed by Dr. Chris Zervas, Mr. Stephen Gill, and Mr. William Stoney. Mrs. Brenda Via critiqued, edited, and finalized the figures, and provided desktop publishing for this report.

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APPENDIX A. Photographs of Field Operations


Two of the RDI Workhorse ADCPs used for the survey.


105 ft. C-tractor tug used for the survey.

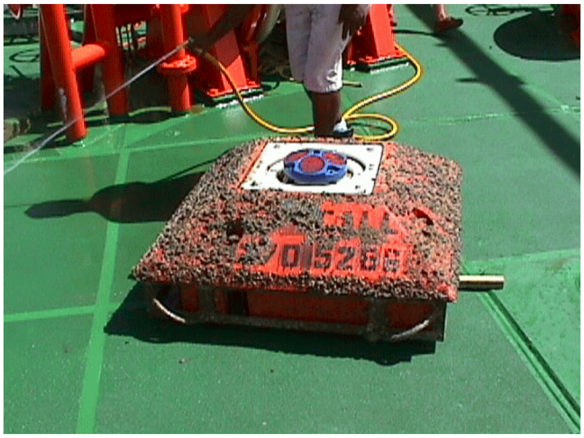

Loading a cleaned-up bottom-mount back onto the vessel, ready for re-deployment.

Initial retrieval of a recovery pod from a small support boat.

Preparing for the deployment of a bottom-mount using an acoustic release crane.

Deployment of a bottom-mount over the side of the vessel using an acoustic release and crane.

Lifting a recovery pod onto the vessel.



Barnacle growth on a recovery pod after retrieval.

APPENDIX B. Tidal Current Tables, 2000 (Tables 1 and 2 for the St. Johns River)

St. Johns River Entrance, Florida, 2000

F–Flood, Dir. 262 ° True E–Ebb, Dir. 081 ° True

January

Day	Slack h m	Maximum h m	knots
1 Sa	0016	0310	2.0 F
	0631	1011	2.0 E
	1307	1553	1.4 F
	1835	2158	2.0 E
2 Su	0104	0406	2.0 F
	0720	1056	2.0 E
	1359	1651	1.5 F
	1925	2238	1.9 E
3 M	0152	0452	2.1 F
	0805	1139	2.0 E
	1447	1732	1.5 F
	2011	2314	1.9 E
4 Tu	0237	0531	2.2 F
	0848	1219	2.0 E
	1533	1805	1.6 F
	2054	2345	1.9 E
5 W	0320	0607	2.3 F
	0929	1253	2.0 E
	1615	1838	1.6 F
	2136		
6 Th ●		0017	1.9 E
	0359	0645	2.3 F
	1009	1315	2.0 E
	1657	1913	1.6 F
	2216		
7 F		0051	1.9 E
	0438	0723	2.3 F
	1048	1336	2.1 E
	1737	1952	1.6 F
	2255		
8 Sa		0128	1.9 E
	0516	0804	2.3 F
	1128	1408	2.1 E
	1818	2033	1.6 F
	2335		
9 Su		0208	1.9 E
	0556	0848	2.3 F
	1208	1444	2.1 E
	1859	2118	1.6 F
10 M	0016	0250	1.9 E
	0641	0934	2.2 F
	1247	1524	2.1 E
	1939	2204	1.8 F
11 Tu	0101	0334	1.9 E
	0730	1021	2.1 F
	1327	1606	2.1 E
	2019	2251	1.9 F
12 W	0148	0422	2.0 E
	0823	1109	2.0 F
	1408	1651	2.1 E
	2100	2338	2.1 F
13 Th	0238	0513	2.0 E
	0919	1158	2.0 F
	1451	1741	2.1 E
	2142		
14 F ◐		0026	2.3 F
	0332	0609	2.0 E
	1015	1247	1.9 F
	1540	1834	2.2 E
	2228		
15 Sa		0116	2.4 F
	0430	0707	2.1 E
	1113	1340	1.8 F
	1636	1930	2.2 E
	2318		

Day	Slack h m	Maximum h m	knots
16 Su		0210	2.5 F
	0531	0807	2.2 E
	1213	1437	1.7 F
	1737	2027	2.2 E
17 M	0013	0308	2.6 F
	0632	0906	2.3 E
	1315	1539	1.7 F
	1840	2124	2.3 E
18 Tu	0111	0409	2.7 F
	0731	1005	2.3 E
	1417	1642	1.8 F
	1940	2221	2.4 E
19 W	0211	0509	2.9 F
	0828	1104	2.4 E
	1516	1741	1.9 F
	2037	2318	2.4 E
20 Th ○	0309	0605	3.0 F
	0923	1204	2.5 E
	1611	1837	2.0 F
	2133		
21 F		0016	2.4 E
	0406	0659	3.0 F
	1016	1303	2.5 E
	1703	1930	2.1 F
	2228		
22 Sa		0114	2.4 E
	0501	0752	2.9 F
	1109	1400	2.4 E
	1754	2023	2.1 F
	2325		
23 Su		0212	2.3 E
	0558	0846	2.7 F
	1201	1452	2.4 E
	1845	2117	2.1 F
24 M	0021	0311	2.2 E
	0656	0941	2.5 F
	1251	1542	2.2 E
	1935	2211	2.1 F
25 Tu	0118	0414	2.0 E
	0756	1035	2.2 F
	1341	1633	2.1 E
	2025	2303	2.1 F
26 W	0213	0536	1.9 E
	0855	1127	2.0 F
	1430	1728	2.0 E
	2114	2351	2.1 F
27 Th	0308	0653	1.8 E
	0951	1216	1.7 F
	1520	1831	1.9 E
	2201		
28 F ◑		0037	2.0 F
	0403	0753	1.8 E
	1045	1303	1.6 F
	1610	1933	1.8 E
	2249		
29 Sa		0124	2.0 F
	0457	0845	1.7 E
	1136	1352	1.4 F
	1702	2026	1.8 E
	2337		
30 Su		0213	1.9 F
	0551	0933	1.7 E
	1228	1445	1.3 F
	1756	2112	1.8 E
31 M	0027	0306	1.8 F
	0643	1018	1.7 E
	1321	1545	1.3 F
	1848	2155	1.8 E

February

Day	Slack h m	Maximum h m	knots
1 Tu	0117	0402	1.9 F
	0732	1103	1.8 E
	1412	1642	1.3 F
	1938	2235	1.8 E
2 W	0206	0453	2.0 F
	0818	1146	1.8 E
	1501	1728	1.4 F
	2025	2313	1.8 E
3 Th	0252	0538	2.1 F
	0901	1224	1.9 E
	1547	1808	1.5 F
	2108	2349	1.9 E
4 F	0335	0619	2.2 F
	0942	1250	2.0 E
	1629	1846	1.6 F
	2149		
5 Sa ●		0026	1.9 E
	0416	0659	2.3 F
	1022	1312	2.0 E
	1708	1926	1.7 F
	2230		
6 Su		0105	2.0 E
	0456	0741	2.3 F
	1101	1342	2.1 E
	1746	2007	1.8 F
	2311		
7 M		0145	2.0 E
	0538	0824	2.3 F
	1140	1418	2.2 E
	1823	2050	1.9 F
	2353		
8 Tu		0227	2.1 E
	0623	0909	2.2 F
	1219	1456	2.2 E
	1901	2136	2.1 F
9 W	0037	0312	2.1 E
	0712	0957	2.1 F
	1259	1538	2.2 E
	1941	2223	2.2 F
10 Th	0124	0358	2.2 E
	0804	1045	2.0 F
	1341	1623	2.2 E
	2024	2311	2.4 F
11 F	0213	0448	2.2 E
	0859	1134	1.9 F
	1426	1712	2.2 E
	2111		
12 Sa ◐		0001	2.5 F
	0306	0542	2.2 E
	0955	1225	1.9 F
	1516	1806	2.1 E
	2202		
13 Su		0052	2.5 F
	0404	0641	2.1 E
	1053	1318	1.8 F
	1614	1905	2.1 E
	2257		
14 M		0147	2.5 F
	0508	0743	2.1 E
	1154	1415	1.7 F
	1719	2006	2.1 E
	2356		
15 Tu		0246	2.5 F
	0613	0848	2.1 E
	1258	1519	1.6 F
	1825	2109	2.2 E

Day	Slack h m	Maximum h m	knots
16 W	0058	0351	2.6 F
	0715	0954	2.2 E
	1402	1627	1.7 F
	1928	2211	2.2 E
17 Th	0201	0455	2.7 F
	0814	1100	2.3 E
	1501	1731	1.9 F
	2026	2314	2.3 E
18 F	0301	0555	2.8 F
	0909	1206	2.4 E
	1554	1827	2.0 F
	2122		
19 Sa ○		0017	2.4 E
	0358	0649	2.8 F
	1000	1304	2.4 E
	1642	1917	2.2 F
	2216		
20 Su		0118	2.4 E
	0452	0739	2.7 F
	1050	1352	2.4 E
	1728	2004	2.3 F
	2308		
21 M		0213	2.4 E
	0545	0829	2.6 F
	1138	1433	2.3 E
	1813	2052	2.3 F
22 Tu	0000	0302	2.3 E
	0639	0918	2.3 F
	1225	1511	2.2 E
	1858	2139	2.2 F
23 W	0051	0349	2.1 E
	0733	1007	2.1 F
	1311	1551	2.1 E
	1944	2225	2.2 F
24 Th	0141	0435	2.0 E
	0826	1054	1.8 F
	1356	1633	2.0 E
	2031	2311	2.1 F
25 F	0230	0525	1.8 E
	0918	1139	1.7 F
	1442	1720	1.8 E
	2119	2355	2.0 F
26 Sa ◑	0320	0633	1.7 E
	1007	1222	1.5 F
	1529	1812	1.7 E
	2208		
27 Su		0040	1.9 F
	0412	0745	1.6 E
	1056	1307	1.4 F
	1620	1911	1.7 E
	2257		
28 M		0127	1.8 F
	0505	0840	1.5 E
	1146	1356	1.3 F
	1714	2010	1.6 E
	2348		
29 Tu		0218	1.7 F
	0600	0929	1.6 E
	1239	1450	1.2 F
	1810	2104	1.7 E

March

Day	Slack h m	Maximum h m	knots
1 W	0040	0314	1.7 F
	0653	1016	1.6 E
	1333	1550	1.3 F
	1904	2152	1.7 E
2 Th	0132	0411	1.8 F
	0743	1059	1.7 E
	1425	1646	1.4 F
	1953	2236	1.8 E
3 F	0222	0504	2.0 F
	0828	1135	1.8 E
	1511	1734	1.6 F
	2039	2318	1.9 E
4 Sa	0309	0550	2.1 F
	0911	1204	2.0 E
	1553	1816	1.8 F
	2122	2359	2.0 E
5 Su ●	0354	0633	2.2 F
	0951	1234	2.1 E
	1631	1857	2.0 F
	2204		
6 M		0040	2.1 E
	0437	0716	2.2 F
	1030	1309	2.2 E
	1707	1939	2.2 F
	2245		
7 Tu		0122	2.2 E
	0521	0759	2.2 F
	1109	1347	2.2 E
	1744	2022	2.3 F
	2328		
8 W		0205	2.3 E
	0606	0845	2.1 F
	1150	1428	2.3 E
	1822	2108	2.4 F
9 Th	0013	0249	2.4 E
	0655	0933	2.1 F
	1232	1511	2.3 E
	1905	2157	2.5 F
10 F	0101	0335	2.4 E
	0747	1023	2.0 F
	1318	1558	2.2 E
	1953	2247	2.5 F
11 Sa	0151	0425	2.3 E
	0842	1114	1.9 F
	1407	1648	2.2 E
	2046	2338	2.5 F
12 Su	0246	0519	2.2 E
	0940	1206	1.8 F
	1501	1743	2.1 E
	2143		
13 M ◐		0031	2.5 F
	0345	0620	2.1 E
	1040	1300	1.7 F
	1602	1846	2.0 E
	2243		
14 Tu		0128	2.4 F
	0450	0728	2.0 E
	1142	1400	1.6 F
	1709	1955	1.9 E
	2345		
15 W		0229	2.4 F
	0557	0844	2.0 E
	1245	1506	1.6 F
	1817	2108	2.0 E

Day	Slack h m	Maximum h m	knots
16 Th	0049	0337	2.4 F
	0700	1002	2.1 E
	1346	1619	1.7 F
	1920	2222	2.1 E
17 F	0153	0446	2.5 F
	0758	1110	2.2 E
	1442	1725	2.0 F
	2018	2331	2.3 E
18 Sa	0253	0547	2.6 F
	0851	1206	2.3 E
	1532	1817	2.2 F
	2111		
19 Su ○		0032	2.4 E
	0349	0639	2.6 F
	0941	1253	2.4 E
	1616	1901	2.4 F
	2201		
20 M		0124	2.5 E
	0441	0726	2.5 F
	1027	1332	2.3 E
	1658	1942	2.5 F
	2249		
21 Tu		0209	2.4 E
	0531	0810	2.3 F
	1112	1405	2.3 E
	1739	2023	2.4 F
	2336		
22 W		0246	2.4 E
	0619	0853	2.1 F
	1155	1437	2.2 E
	1820	2104	2.4 F
23 Th	0022	0317	2.2 E
	0707	0936	1.9 F
	1239	1513	2.1 E
	1903	2147	2.3 F
24 F	0107	0348	2.0 E
	0755	1019	1.7 F
	1322	1552	1.9 E
	1949	2232	2.1 F
25 Sa	0152	0426	1.9 E
	0842	1102	1.6 F
	1405	1636	1.8 E
	2037	2316	2.0 F
26 Su	0239	0509	1.7 E
	0930	1145	1.5 F
	1450	1723	1.7 E
	2127		
27 M ◑		0001	1.9 F
	0327	0600	1.6 E
	1018	1229	1.4 F
	1539	1816	1.6 E
	2217		
28 Tu		0048	1.8 F
	0419	0659	1.5 E
	1107	1317	1.3 F
	1633	1914	1.6 E
	2308		
29 W		0138	1.8 F
	0514	0806	1.5 E
	1159	1409	1.3 F
	1730	2013	1.6 E
30 Th	0001	0232	1.7 F
	0609	0905	1.6 E
	1251	1505	1.3 F
	1827	2108	1.6 E
31 F	0055	0329	1.7 F
	0701	0952	1.7 E
	1341	1603	1.5 F
	1920	2158	1.8 E

Time meridian 75° W. 0000 is midnight. 1200 is noon.

St. Johns River Entrance, Florida, 2000

F–Flood, Dir. 262 ° True   E–Ebb, Dir. 081 ° True

April

	Slack	Maximum	
	h m	h m	knots
1	0149	0426	1.8 F
Sa	0749	1033	1.9 E
	1428	1655	1.8 F
	2008	2244	1.9 E
2	0241	0517	2.0 F
Su	0833	1113	2.0 E
	1509	1742	2.0 F
	2053	2329	2.1 E
3	0330	0604	2.1 F
M	0915	1153	2.1 E
	1548	1826	2.3 F
	2136		
4		0012	2.3 E
Tu	0416	0649	2.1 F
	0956	1233	2.2 E
●	1626	1909	2.5 F
	2219		
5		0056	2.4 E
W	0501	0733	2.1 F
	1037	1316	2.3 E
	1705	1954	2.6 F
	2303		
6		0141	2.5 E
Th	0548	0820	2.1 F
	1120	1400	2.3 E
	1748	2041	2.7 F
	2350		
7		0227	2.5 E
F	0637	0909	2.0 F
	1207	1446	2.3 E
	1835	2132	2.7 F
8	0040	0314	2.5 E
Sa	0731	1002	1.9 F
	1258	1535	2.2 E
	1929	2225	2.6 F
9	0133	0406	2.3 E
Su	0829	1056	1.8 F
	1352	1627	2.1 E
	2028	2319	2.5 F
10	0230	0502	2.2 E
M	0930	1151	1.8 F
	1451	1726	1.9 E
	2130		
11		0015	2.5 F
Tu	0331	0606	2.1 E
	1030	1248	1.7 F
◐	1555	1835	1.8 E
	2233		
12		0113	2.4 F
W	0435	0729	2.0 E
	1130	1349	1.7 F
	1703	2009	1.8 E
	2337		
13		0216	2.2 F
Th	0540	0905	2.1 E
	1229	1458	1.7 F
	1810	2136	1.9 E
14	0041	0326	2.2 F
F	0642	1009	2.1 E
	1326	1614	1.9 F
	1911	2240	2.1 E
15	0145	0439	2.2 F
Sa	0739	1102	2.2 E
	1417	1716	2.1 F
	2006	2338	2.3 E
16	0244	0540	2.3 F
Su	0830	1150	2.3 E
	1504	1803	2.4 F
	2056		
17		0030	2.4 E
M	0338	0629	2.3 F
	0917	1231	2.3 E
	1547	1841	2.5 F
	2143		
18		0116	2.5 E
Tu	0428	0710	2.2 F
	1002	1305	2.2 E
○	1627	1917	2.6 F
	2227		
19		0154	2.4 E
W	0513	0748	2.1 F
	1044	1334	2.2 E
	1706	1953	2.5 F
	2310		
20		0223	2.3 E
Th	0557	0825	1.9 F
	1126	1404	2.1 E
	1745	2031	2.4 F
	2353		
21		0245	2.2 E
F	0640	0904	1.8 F
	1207	1439	2.0 E
	1827	2113	2.3 F
22	0035	0313	2.1 E
Sa	0724	0945	1.6 F
	1248	1518	1.9 E
	1911	2156	2.1 F
23	0118	0349	1.9 E
Su	0809	1028	1.5 F
	1331	1600	1.8 E
	1957	2242	2.0 F
24	0202	0431	1.8 E
M	0856	1112	1.5 F
	1415	1645	1.7 E
	2046	2328	2.0 F
25	0247	0519	1.7 E
Tu	0944	1157	1.4 F
	1502	1735	1.6 E
	2137		
26		0014	1.9 F
W	0336	0613	1.7 E
	1032	1244	1.4 F
◑	1554	1830	1.6 E
	2228		
27		0103	1.8 F
Th	0427	0710	1.7 E
	1119	1334	1.5 F
	1651	1928	1.6 E
	2322		
28		0154	1.8 F
F	0521	0807	1.7 E
	1207	1427	1.6 F
	1749	2026	1.7 E
29	0018	0249	1.7 F
Sa	0614	0857	1.8 E
	1253	1522	1.8 F
	1844	2119	1.8 E
30	0116	0346	1.7 F
Su	0704	0944	2.0 E
	1338	1616	2.0 F
	1935	2209	2.0 E

May

	Slack	Maximum	
	h m	h m	knots
1	0211	0442	1.8 F
M	0751	1029	2.1 E
	1422	1707	2.3 F
	2022	2256	2.2 E
2	0303	0533	1.9 F
Tu	0836	1114	2.2 E
	1505	1754	2.6 F
	2108	2343	2.4 E
3	0352	0621	2.0 F
W	0920	1159	2.3 E
	1548	1841	2.8 F
●	2153		
4		0030	2.5 E
Th	0439	0708	2.1 F
	1005	1246	2.4 E
	1632	1928	2.9 F
	2240		
5		0117	2.6 E
F	0528	0756	2.0 F
	1053	1334	2.4 E
	1720	2017	2.9 F
	2330		
6		0206	2.6 E
Sa	0620	0848	2.0 F
	1145	1423	2.3 E
	1812	2110	2.8 F
7	0022	0256	2.5 E
Su	0716	0943	1.9 F
	1241	1515	2.2 E
	1910	2206	2.7 F
8	0118	0350	2.3 E
M	0817	1040	1.8 F
	1340	1611	2.0 E
	2013	2303	2.5 F
9	0216	0450	2.2 E
Tu	0918	1139	1.8 F
	1442	1715	1.8 E
	2118		
10		0000	2.4 F
W	0316	0604	2.1 E
	1017	1238	1.8 F
◐	1548	1852	1.7 E
	2223		
11		0059	2.3 F
Th	0418	0756	2.1 E
	1113	1339	1.8 F
	1655	2036	1.9 E
	2327		
12		0202	2.1 F
F	0520	0901	2.1 E
	1207	1447	1.9 F
	1758	2139	2.0 E
13	0030	0313	2.0 F
Sa	0619	0953	2.2 E
	1258	1559	2.0 F
	1857	2234	2.2 E
14	0132	0427	2.0 F
Su	0714	1040	2.2 E
	1347	1657	2.2 F
	1950	2327	2.3 E
15	0230	0527	2.0 F
M	0805	1124	2.2 E
	1434	1741	2.4 F
	2038		
16		0015	2.4 E
Tu	0322	0614	2.0 F
	0851	1202	2.2 E
	1517	1817	2.5 F
	2122		
17		0058	2.4 E
W	0409	0651	2.0 F
	0934	1235	2.1 E
	1557	1851	2.5 F
	2204		
18		0135	2.3 E
Th	0452	0724	1.9 F
	1016	1303	2.1 E
○	1637	1925	2.5 F
	2245		
19		0200	2.2 E
F	0533	0757	1.8 F
	1056	1334	2.0 E
	1716	2002	2.4 F
	2325		
20		0217	2.1 E
Sa	0614	0833	1.7 F
	1137	1409	2.0 E
	1755	2042	2.3 F
21	0006	0245	2.0 E
Su	0656	0914	1.5 F
	1217	1447	1.9 E
	1837	2125	2.2 F
22	0048	0321	2.0 E
M	0741	0957	1.5 F
	1259	1528	1.8 E
	1922	2211	2.1 F
23	0130	0403	1.9 E
Tu	0827	1043	1.5 F
	1343	1613	1.7 E
	2010	2257	2.0 F
24	0213	0448	1.9 E
W	0913	1129	1.5 F
	1429	1701	1.7 E
	2101	2344	2.0 F
25	0258	0537	1.8 E
Th	0957	1215	1.6 F
	1519	1753	1.6 E
	2153		
26		0032	1.9 F
F	0344	0629	1.8 E
	1040	1302	1.7 F
◑	1613	1850	1.7 E
	2248		
27		0121	1.8 F
Sa	0433	0722	1.9 E
	1122	1352	1.9 F
	1710	1947	1.8 E
	2344		
28		0213	1.7 F
Su	0524	0813	2.0 E
	1205	1444	2.1 F
	1807	2042	1.9 E
29	0041	0309	1.7 F
M	0617	0902	2.1 E
	1251	1539	2.3 F
	1900	2134	2.1 E
30	0139	0406	1.7 F
Tu	0708	0951	2.2 E
	1338	1633	2.6 F
	1951	2224	2.3 E
31	0234	0501	1.8 F
W	0758	1039	2.3 E
	1427	1725	2.8 F
	2041	2314	2.5 E

June

	Slack	Maximum	
	h m	h m	knots
1	0326	0553	1.9 F
Th	0848	1129	2.4 E
	1517	1815	3.0 F
	2130		
2		0004	2.6 E
F	0417	0643	2.0 F
	0938	1219	2.5 E
●	1607	1905	3.0 F
	2220		
3		0055	2.6 E
Sa	0509	0734	2.0 F
	1030	1311	2.4 E
	1659	1957	3.0 F
	2313		
4		0148	2.5 E
Su	0603	0828	1.9 F
	1126	1404	2.3 E
	1755	2051	2.8 F
5	0007	0242	2.5 E
M	0701	0925	1.9 F
	1225	1459	2.1 E
	1855	2148	2.7 F
6	0103	0339	2.3 E
Tu	0801	1025	1.8 F
	1327	1559	2.0 E
	2000	2247	2.5 F
7	0201	0443	2.2 E
W	0900	1126	1.9 F
	1431	1712	1.8 E
	2106	2346	2.3 F
8	0258	0616	2.1 E
Th	0956	1224	1.9 F
	1535	1917	1.8 E
◐	2210		
9		0044	2.2 F
F	0357	0741	2.1 E
	1048	1323	2.0 F
	1638	2027	1.9 E
	2312		
10		0145	2.0 F
Sa	0455	0838	2.1 E
	1138	1423	2.0 F
	1739	2124	2.1 E
11	0013	0252	1.8 F
Su	0551	0927	2.1 E
	1227	1527	2.1 F
	1835	2216	2.2 E
12	0112	0405	1.7 F
M	0645	1012	2.1 E
	1315	1627	2.2 F
	1927	2305	2.2 E
13	0208	0506	1.7 F
Tu	0736	1054	2.1 E
	1403	1714	2.3 F
	2014	2352	2.2 E
14	0259	0552	1.7 F
W	0822	1133	2.1 E
	1448	1751	2.4 F
	2058		
15		0035	2.2 E
Th	0345	0628	1.7 F
	0906	1207	2.0 E
	1531	1825	2.4 F
	2140		
16		0113	2.2 E
F	0427	0658	1.7 F
	0948	1236	2.0 E
○	1611	1859	2.4 F
	2220		
17		0141	2.1 E
Sa	0508	0729	1.6 F
	1028	1307	2.0 E
	1650	1936	2.3 F
	2300		
18		0157	2.1 E
Su	0549	0805	1.6 F
	1109	1342	1.9 E
	1729	2015	2.3 F
	2341		
19		0223	2.0 E
M	0631	0846	1.5 F
	1149	1420	1.8 E
	1809	2058	2.2 F
20	0021	0258	2.0 E
Tu	0714	0929	1.5 F
	1231	1501	1.8 E
	1852	2143	2.1 F
21	0102	0337	2.0 E
W	0757	1015	1.6 F
	1314	1544	1.8 E
	1939	2229	2.1 F
22	0143	0419	2.0 E
Th	0839	1100	1.7 F
	1400	1631	1.8 E
	2030	2316	2.0 F
23	0223	0504	2.0 E
F	0920	1146	1.8 F
	1447	1721	1.8 E
	2123		
24		0003	1.9 F
Sa	0305	0552	2.0 E
	0959	1232	2.0 F
◑	1538	1815	1.8 E
	2217		
25		0051	1.9 F
Su	0349	0642	2.0 E
	1040	1320	2.2 F
	1633	1911	1.9 E
	2312		
26		0141	1.8 F
M	0439	0734	2.1 E
	1123	1411	2.3 F
	1730	2007	2.1 E
27	0009	0235	1.7 F
Tu	0534	0827	2.2 E
	1211	1505	2.5 F
	1828	2102	2.2 E
28	0107	0333	1.7 F
W	0631	0919	2.3 E
	1303	1602	2.7 F
	1923	2156	2.3 E
29	0205	0431	1.8 F
Th	0727	1011	2.4 E
	1358	1659	2.8 F
	2017	2249	2.4 E
30	0302	0528	1.9 F
F	0822	1104	2.5 E
	1454	1753	3.0 F
	2110	2343	2.5 E

Time meridian 75° W. 0000 is midnight. 1200 is noon.

St. Johns River Entrance, Florida, 2000

F–Flood, Dir. 262 ° True E–Ebb, Dir. 081 ° True

July

	Slack	Maximum			Slack	Maximum	
	h m	h m	knots		h m	h m	knots
1 Sa ●	0357	0622	2.0 F	**16** Su ○		0121	2.0 E
	0916	1158	2.5 E		0442	0703	1.6 F
	1549	1846	3.0 F		1002	1243	1.9 E
	2203				1627	1911	2.3 F
					2236		
2 Su		0038	2.5 E	**17** M		0141	2.0 E
	0451	0716	2.0 F		0523	0739	1.6 F
	1012	1253	2.4 E		1043	1318	1.9 E
	1644	1939	3.0 F		1706	1950	2.3 F
	2257				2315		
3 M		0134	2.5 E	**18** Tu		0202	2.0 E
	0546	0811	2.0 F		0603	0819	1.6 F
	1110	1349	2.3 E		1123	1356	1.9 E
	1742	2034	2.8 F		1746	2032	2.2 F
	2351				2355		
4 Tu		0231	2.4 E	**19** W		0233	2.1 E
	0642	0908	2.0 F		0643	0901	1.7 F
	1211	1448	2.2 E		1205	1436	1.9 E
	1842	2132	2.7 F		1829	2116	2.1 F
5 W	0046	0329	2.3 E	**20** Th	0034	0310	2.1 E
	0738	1008	2.0 F		0722	0945	1.7 F
	1312	1551	2.0 E		1247	1518	1.9 E
	1946	2230	2.4 F		1915	2203	2.1 F
6 Th	0141	0431	2.2 E	**21** F	0112	0349	2.1 E
	0833	1106	2.0 F		0801	1031	1.9 F
	1413	1718	1.9 E		1331	1604	1.9 E
	2050	2328	2.2 F		2006	2249	2.0 F
7 F	0235	0550	2.1 E	**22** Sa	0151	0432	2.1 E
	0926	1202	2.1 F		0839	1117	2.1 F
	1513	1859	1.9 E		1417	1652	2.0 E
	2153				2058	2336	1.9 F
8 Sa ◐		0024	2.0 F	**23** Su	0231	0518	2.1 E
	0330	0707	2.1 E		0920	1203	2.3 F
	1016	1255	2.1 F		1506	1744	2.0 E
	1613	2004	2.0 E		2151		
	2252						
9 Su		0120	1.8 F	**24** M ◑		0024	1.9 F
	0424	0804	2.0 E		0314	0608	2.1 E
	1105	1347	2.1 F		1003	1251	2.4 F
	1711	2059	2.0 E		1600	1839	2.1 E
	2349				2245		
10 M		0219	1.6 F	**25** Tu		0113	1.8 F
	0519	0854	2.0 E		0404	0701	2.1 E
	1153	1443	2.1 F		1050	1342	2.5 F
	1806	2150	2.0 E		1659	1936	2.1 E
					2341		
11 Tu	0045	0326	1.5 F	**26** W		0207	1.7 F
	0613	0940	2.0 E		0501	0757	2.2 E
	1242	1542	2.1 F		1142	1437	2.6 F
	1858	2237	2.0 E		1800	2034	2.2 E
12 W	0139	0433	1.5 F	**27** Th	0040	0305	1.7 F
	0704	1023	2.0 E		0603	0853	2.3 E
	1332	1638	2.1 F		1239	1537	2.6 F
	1947	2324	2.0 E		1900	2132	2.3 E
13 Th	0230	0523	1.5 F	**28** F	0142	0407	1.7 F
	0753	1104	1.9 E		0705	0949	2.4 E
	1420	1722	2.1 F		1339	1637	2.8 F
	2032				1958	2229	2.3 E
14 F		0008	2.0 E	**29** Sa	0242	0508	1.8 F
	0317	0600	1.5 F		0804	1046	2.4 E
	0838	1140	1.9 E		1438	1736	2.9 F
	1505	1759	2.2 F		2053	2328	2.4 E
	2115						
15 Sa		0048	2.0 E	**30** Su ●	0339	0606	2.0 F
	0401	0631	1.6 F		0902	1143	2.4 E
	0921	1212	1.9 E		1537	1831	3.0 F
	1547	1834	2.3 F		2147		
	2156						
				31 M		0026	2.5 E
					0433	0700	2.1 F
					0959	1241	2.4 E
					1634	1925	2.9 F
					2240		

August

	Slack	Maximum			Slack	Maximum	
	h m	h m	knots		h m	h m	knots
1 Tu		0124	2.5 E	**16** W		0133	2.1 E
	0525	0754	2.1 F		0529	0750	1.8 F
	1056	1341	2.4 E		1057	1332	2.0 E
	1731	2018	2.8 F		1725	2007	2.2 F
	2333				2325		
2 W		0219	2.4 E	**17** Th		0204	2.1 E
	0616	0848	2.2 F		0605	0832	1.9 F
	1154	1440	2.3 E		1137	1411	2.0 E
	1829	2114	2.6 F		1808	2050	2.1 F
3 Th	0025	0312	2.4 E	**18** F	0003	0240	2.1 E
	0707	0944	2.2 F		0641	0915	2.0 F
	1251	1542	2.1 E		1219	1453	2.1 E
	1930	2210	2.3 F		1855	2136	2.0 F
4 F	0117	0404	2.2 E	**19** Sa	0041	0319	2.1 E
	0759	1038	2.2 F		0719	1001	2.2 F
	1348	1657	2.0 E		1302	1537	2.2 E
	2031	2305	2.1 F		1944	2223	2.0 F
5 Sa	0208	0500	2.1 E	**20** Su	0120	0401	2.1 E
	0850	1130	2.2 F		0800	1048	2.3 F
	1444	1824	1.9 E		1348	1624	2.2 E
	2129	2357	1.9 F		2035	2311	1.9 F
6 Su ◐	0259	0607	2.0 E	**21** M	0202	0447	2.1 E
	0940	1218	2.1 F		0844	1136	2.4 F
	1539	1931	1.9 E		1438	1715	2.2 E
	2225				2128	2359	1.8 F
7 M		0047	1.7 F	**22** Tu ◑	0247	0538	2.1 E
	0350	0717	1.9 E		0933	1225	2.5 F
	1029	1306	2.1 F		1533	1810	2.1 E
	1635	2027	1.8 E		2223		
	2318						
8 Tu		0137	1.5 F	**23** W		0050	1.8 F
	0443	0815	1.8 E		0339	0633	2.1 E
	1119	1356	2.0 F		1025	1318	2.5 F
	1730	2117	1.8 E		1633	1910	2.1 E
					2321		
9 W	0010	0231	1.4 F	**24** Th		0144	1.7 F
	0538	0905	1.8 E		0440	0733	2.1 E
	1209	1451	1.9 F		1123	1414	2.5 F
	1824	2205	1.8 E		1737	2012	2.1 E
10 Th	0103	0334	1.3 F	**25** F	0022	0244	1.6 F
	0631	0951	1.8 E		0547	0834	2.2 E
	1301	1550	1.9 F		1224	1516	2.5 F
	1915	2251	1.8 E		1841	2116	2.2 E
11 F	0155	0438	1.3 F	**26** Sa	0125	0349	1.7 F
	0722	1034	1.8 E		0653	0936	2.2 E
	1351	1644	1.9 F		1327	1620	2.6 F
	2002	2336	1.8 E		1941	2218	2.3 E
12 Sa	0244	0524	1.4 F	**27** Su	0225	0454	1.8 F
	0810	1113	1.8 E		0754	1037	2.3 E
	1438	1728	2.0 F		1429	1722	2.7 F
	2046				2038	2320	2.4 E
13 Su		0018	1.9 E	**28** M	0321	0553	2.1 F
	0330	0600	1.5 F		0852	1139	2.4 E
	0855	1147	1.9 E		1528	1819	2.8 F
	1522	1808	2.1 F		2131		
	2128						
14 M		0052	2.0 E	**29** Tu ●		0019	2.4 E
	0413	0635	1.6 F		0411	0646	2.3 F
	0937	1219	1.9 E		0947	1240	2.5 E
	1604	1846	2.2 F		1625	1911	2.8 F
	2208				2221		
15 Tu ○		0112	2.0 E	**30** W		0113	2.5 E
	0452	0712	1.7 F		0459	0736	2.4 F
	1018	1254	1.9 E		1041	1339	2.5 E
	1644	1925	2.2 F		1720	2002	2.6 F
	2247				2311		
				31 Th		0201	2.4 E
					0545	0825	2.4 F
					1134	1434	2.4 E
					1815	2054	2.4 F

September

	Slack	Maximum			Slack	Maximum	
	h m	h m	knots		h m	h m	knots
1 F	0000	0245	2.3 E	**16** Sa		0208	2.2 E
	0632	0914	2.4 F		0600	0845	2.4 F
	1227	1525	2.3 E		1151	1428	2.3 E
	1910	2145	2.1 F		1834	2109	2.0 F
2 Sa	0048	0329	2.2 E	**17** Su	0010	0248	2.2 E
	0720	1003	2.3 F		0639	0931	2.4 F
	1319	1617	2.1 E		1236	1512	2.3 E
	2006	2236	1.9 F		1923	2158	1.9 F
3 Su	0136	0414	2.0 E	**18** M	0052	0332	2.2 E
	0810	1052	2.2 F		0724	1020	2.5 F
	1410	1717	1.9 E		1324	1559	2.3 E
	2100	2324	1.7 F		2015	2248	1.8 F
4 M	0225	0503	1.9 E	**19** Tu	0138	0420	2.1 E
	0901	1139	2.1 F		0815	1111	2.5 F
	1502	1838	1.7 E		1415	1650	2.2 E
	2152				2111	2339	1.8 F
5 Tu ◐		0010	1.5 F	**20** W ◑	0228	0513	2.0 E
	0314	0600	1.7 E		0910	1203	2.5 F
	0952	1226	2.0 F		1512	1747	2.1 E
	1555	1944	1.6 E		2209		
	2243						
6 W		0056	1.4 F	**21** Th		0031	1.7 F
	0406	0710	1.7 E		0326	0611	2.0 E
	1043	1314	1.8 F		1009	1258	2.4 F
	1649	2038	1.6 E		1614	1850	2.1 E
	2333				2308		
7 Th		0144	1.3 F	**22** F		0127	1.7 F
	0500	0819	1.6 E		0431	0716	1.9 E
	1135	1405	1.7 F		1111	1356	2.4 F
	1744	2127	1.6 E		1720	2000	2.1 E
8 F	0024	0238	1.2 F	**23** Sa	0009	0229	1.6 F
	0556	0913	1.7 E		0540	0826	2.0 E
	1227	1500	1.7 F		1215	1500	2.4 F
	1838	2212	1.7 E		1825	2111	2.1 E
9 Sa	0117	0339	1.3 F	**24** Su	0110	0337	1.7 F
	0651	0959	1.7 E		0646	0937	2.1 E
	1318	1558	1.8 F		1319	1607	2.4 F
	1927	2256	1.8 E		1925	2218	2.2 E
10 Su	0207	0436	1.4 F	**25** M	0207	0444	2.0 F
	0741	1040	1.8 E		0747	1046	2.3 E
	1409	1651	1.9 F		1422	1712	2.5 F
	2013	2334	1.9 E		2020	2318	2.3 E
11 M	0254	0523	1.6 F	**26** Tu	0259	0542	2.2 F
	0827	1116	1.8 E		0842	1150	2.4 E
	1456	1737	2.0 F		1521	1808	2.6 F
	2055				2112		
12 Tu		0003	2.0 E	**27** W ●		0010	2.4 E
	0336	0603	1.8 F		0346	0631	2.5 F
	0910	1152	1.9 E		0934	1248	2.5 E
	1540	1818	2.1 F		1616	1859	2.6 F
	2136				2200		
13 W ○		0026	2.1 E	**28** Th		0056	2.4 E
	0414	0641	2.0 F		0430	0716	2.6 F
	0950	1228	2.0 E		1024	1339	2.5 E
	1623	1859	2.2 F		1707	1945	2.4 F
	2214				2247		
14 Th		0055	2.1 E	**29** F		0136	2.3 E
	0449	0720	2.2 F		0513	0759	2.6 F
	1030	1306	2.2 E		1112	1422	2.5 E
	1705	1940	2.1 F		1758	2031	2.2 F
	2252				2333		
15 F		0130	2.2 E	**30** Sa		0215	2.2 E
	0524	0801	2.3 F		0556	0843	2.5 F
	1109	1346	2.3 E		1200	1500	2.3 E
	1749	2024	2.1 F		1848	2117	2.0 F
	2330						

Time meridian 75° W. 0000 is midnight. 1200 is noon.

St. Johns River Entrance, Florida, 2000

F–Flood, Dir. 262 ° True   E–Ebb, Dir. 081 ° True

October

	Slack h m	Maximum h m	knots
1 Su	0018	0254	2.1 E
	0641	0928	2.4 F
	1248	1536	2.1 E
	1938	2203	1.7 F
2 M	0103	0335	2.0 E
	0730	1015	2.2 F
	1335	1614	1.9 E
	2028	2248	1.6 F
3 Tu	0149	0419	1.8 E
	0821	1101	2.1 F
	1424	1659	1.7 E
	2117	2333	1.5 F
4 W	0237	0508	1.7 E
	0913	1148	1.9 F
	1514	1753	1.6 E
	2206		
5 Th		0018	1.4 F
	0328	0604	1.6 E
	1005	1235	1.8 F
◐	1606	1927	1.5 E
	2256		
6 F		0105	1.3 F
	0422	0708	1.5 E
	1057	1324	1.7 F
	1700	2034	1.6 E
	2345		
7 Sa		0156	1.3 F
	0520	0816	1.5 E
	1149	1417	1.7 F
	1754	2120	1.6 E
8 Su	0036	0251	1.4 F
	0616	0912	1.6 E
	1243	1513	1.7 F
	1846	2158	1.8 E
9 M	0125	0348	1.5 F
	0709	0958	1.7 E
	1336	1609	1.7 F
	1933	2231	1.9 E
10 Tu	0210	0440	1.7 F
	0756	1039	1.9 E
	1427	1701	1.9 F
	2017	2304	2.0 E
11 W	0252	0525	2.0 F
	0839	1118	2.0 E
	1515	1747	2.0 F
	2058	2338	2.1 E
12 Th	0330	0608	2.3 F
	0920	1157	2.2 E
	1600	1830	2.0 F
	2138		
13 F		0015	2.2 E
	0407	0649	2.5 F
	1001	1238	2.3 E
○	1643	1913	2.1 F
	2217		
14 Sa		0055	2.2 E
	0444	0731	2.6 F
	1042	1319	2.4 E
	1727	1957	2.0 F
	2257		
15 Su		0136	2.3 E
	0523	0817	2.6 F
	1126	1403	2.5 E
	1813	2044	1.9 F
	2340		
16 M		0220	2.2 E
	0606	0905	2.6 F
	1213	1449	2.4 E
	1903	2134	1.8 F
17 Tu	0027	0307	2.2 E
	0656	0956	2.6 F
	1303	1537	2.4 E
	1959	2227	1.8 F
18 W	0119	0357	2.1 E
	0753	1050	2.5 F
	1358	1630	2.2 E
	2058	2321	1.7 F
19 Th	0216	0452	1.9 E
	0855	1145	2.5 F
	1457	1730	2.1 E
	2159		
20 F		0017	1.7 F
	0319	0555	1.8 E
	0959	1242	2.4 F
◑	1559	1839	2.0 E
	2258		
21 Sa		0116	1.7 F
	0427	0711	1.8 E
	1103	1342	2.3 F
	1704	2002	2.0 E
	2356		
22 Su		0218	1.8 F
	0535	0845	1.9 E
	1208	1447	2.2 F
	1807	2121	2.1 E
23 M	0051	0327	1.9 F
	0639	1001	2.1 E
	1312	1557	2.2 F
	1906	2220	2.2 E
24 Tu	0144	0434	2.1 F
	0737	1102	2.3 E
	1414	1704	2.3 F
	2000	2310	2.3 E
25 W	0234	0529	2.4 F
	0830	1157	2.4 E
	1511	1759	2.3 F
	2050	2355	2.3 E
26 Th	0319	0614	2.6 F
	0918	1247	2.5 E
	1604	1846	2.3 F
	2137		
27 F		0035	2.3 E
	0402	0654	2.7 F
	1004	1331	2.5 E
●	1652	1927	2.2 F
	2221		
28 Sa		0110	2.2 E
	0443	0733	2.7 F
	1049	1406	2.4 E
	1738	2007	2.0 F
	2304		
29 Su		0145	2.2 E
	0525	0813	2.5 F
	1134	1434	2.3 E
	1823	2047	1.8 F
	2347		
30 M		0222	2.1 E
	0608	0855	2.4 F
	1218	1502	2.1 E
	1908	2129	1.6 F
31 Tu	0031	0301	1.9 E
	0653	0940	2.2 F
	1303	1537	1.9 E
	1955	2213	1.5 F

November

	Slack h m	Maximum h m	knots
1 W	0116	0343	1.8 E
	0742	1026	2.0 F
	1348	1618	1.8 E
	2043	2258	1.4 F
2 Th	0202	0429	1.7 E
	0833	1113	1.9 F
	1435	1706	1.7 E
	2132	2344	1.4 F
3 F	0251	0520	1.6 E
	0925	1200	1.8 F
	1523	1801	1.6 E
	2219		
4 Sa		0031	1.4 F
	0345	0616	1.5 E
	1018	1248	1.8 F
◐	1613	1901	1.6 E
	2306		
5 Su		0119	1.5 F
	0441	0718	1.5 E
	1111	1338	1.7 F
	1706	2000	1.7 E
	2352		
6 M		0210	1.6 F
	0538	0818	1.6 E
	1205	1431	1.6 F
	1758	2049	1.8 E
7 Tu	0037	0304	1.7 F
	0631	0910	1.7 E
	1300	1527	1.6 F
	1848	2132	1.9 E
8 W	0121	0357	2.0 F
	0720	0957	1.9 E
	1355	1622	1.7 F
	1934	2214	2.0 E
9 Th	0204	0447	2.2 F
	0806	1041	2.1 E
	1446	1712	1.8 F
	2018	2256	2.2 E
10 F	0246	0534	2.5 F
	0850	1124	2.3 E
	1533	1800	1.9 F
	2100	2338	2.3 E
11 Sa	0327	0619	2.7 F
	0933	1208	2.4 E
	1619	1845	2.0 F
○	2142		
12 Su		0022	2.3 E
	0409	0704	2.8 F
	1017	1253	2.5 E
	1705	1931	2.0 F
	2227		
13 M		0108	2.3 E
	0453	0752	2.8 F
	1104	1340	2.5 E
	1753	2020	1.9 F
	2315		
14 Tu		0156	2.3 E
	0542	0842	2.8 F
	1154	1429	2.5 E
	1846	2113	1.8 F
15 W	0008	0246	2.2 E
	0636	0936	2.7 F
	1247	1520	2.4 E
	1945	2209	1.8 F
16 Th	0105	0339	2.0 E
	0738	1032	2.5 F
	1344	1616	2.2 E
	2046	2307	1.8 F
17 F	0207	0437	1.9 E
	0843	1130	2.4 F
	1442	1718	2.1 E
	2145		
18 Sa		0005	1.8 F
	0313	0547	1.7 E
	0949	1228	2.3 F
◑	1543	1838	2.1 E
	2242		
19 Su		0104	1.8 F
	0420	0746	1.8 E
	1054	1328	2.2 F
	1645	2016	2.1 E
	2335		
20 M		0206	1.9 F
	0526	0905	1.9 E
	1158	1433	2.0 F
	1746	2116	2.2 E
21 Tu	0027	0313	2.1 F
	0627	1003	2.1 E
	1301	1545	2.0 F
	1844	2207	2.2 E
22 W	0118	0418	2.3 F
	0722	1057	2.3 E
	1402	1654	2.0 F
	1938	2253	2.2 E
23 Th	0206	0511	2.5 F
	0813	1148	2.4 E
	1458	1748	2.0 F
	2027	2336	2.2 E
24 F	0252	0555	2.6 F
	0900	1235	2.5 E
	1548	1832	2.0 F
	2112		
25 Sa		0014	2.2 E
	0336	0633	2.6 F
	0944	1317	2.4 E
●	1633	1909	1.9 F
	2156		
26 Su		0047	2.1 E
	0418	0709	2.6 F
	1027	1351	2.3 E
	1716	1943	1.8 F
	2237		
27 M		0119	2.1 E
	0458	0747	2.5 F
	1110	1414	2.2 E
	1758	2019	1.7 F
	2319		
28 Tu		0154	2.0 E
	0540	0827	2.3 F
	1152	1437	2.1 E
	1841	2058	1.6 F
29 W	0001	0232	1.9 E
	0622	0910	2.2 F
	1234	1510	2.0 E
	1925	2141	1.5 F
30 Th	0045	0313	1.8 E
	0708	0955	2.1 F
	1317	1549	1.9 E
	2012	2227	1.5 F

December

	Slack h m	Maximum h m	knots
1 F	0130	0357	1.7 E
	0756	1041	2.0 F
	1400	1633	1.8 E
	2058	2313	1.5 F
2 Sa	0218	0444	1.6 E
	0847	1128	1.9 F
	1443	1721	1.8 E
	2142	2359	1.6 F
3 Su	0308	0536	1.6 E
	0940	1214	1.8 F
	1528	1812	1.8 E
◐	2224		
4 M		0045	1.7 F
	0400	0632	1.6 E
	1033	1302	1.7 F
	1616	1905	1.8 E
	2306		
5 Tu		0133	1.8 F
	0455	0730	1.7 E
	1128	1353	1.7 F
	1706	1956	1.9 E
	2348		
6 W		0223	2.0 F
	0549	0825	1.8 E
	1223	1446	1.6 F
	1757	2044	2.0 E
7 Th	0032	0316	2.2 F
	0642	0916	2.0 E
	1319	1542	1.6 F
	1848	2132	2.1 E
8 F	0118	0410	2.4 F
	0732	1005	2.2 E
	1413	1637	1.7 F
	1937	2218	2.2 E
9 Sa	0205	0501	2.7 F
	0820	1052	2.3 E
	1505	1729	1.8 F
	2024	2306	2.3 E
10 Su	0253	0552	2.8 F
	0907	1141	2.5 E
	1554	1819	1.9 F
	2112	2354	2.4 E
11 M	0342	0641	2.9 F
	0956	1230	2.5 E
	1643	1908	2.0 F
○	2202		
12 Tu		0044	2.4 E
	0432	0731	3.0 F
	1046	1320	2.5 E
	1734	1959	1.9 F
	2255		
13 W		0135	2.3 E
	0525	0823	2.9 F
	1138	1413	2.5 E
	1829	2054	1.9 F
	2353		
14 Th		0229	2.2 E
	0622	0918	2.7 F
	1233	1507	2.4 E
	1928	2153	1.9 F
15 F	0054	0325	2.1 E
	0725	1016	2.6 F
	1328	1604	2.3 E
	2027	2252	1.9 F
16 Sa	0157	0427	1.9 E
	0831	1114	2.4 F
	1425	1709	2.2 E
	2124	2351	2.0 F
17 Su	0301	0552	1.8 E
	0937	1212	2.2 F
	1523	1839	2.1 E
◑	2218		
18 M		0048	2.0 F
	0405	0750	1.9 E
	1041	1311	2.1 F
	1622	2000	2.1 E
	2309		
19 Tu		0146	2.1 F
	0507	0854	2.0 E
	1144	1415	1.9 F
	1721	2056	2.1 E
	2359		
20 W		0248	2.2 F
	0607	0949	2.2 E
	1245	1527	1.8 F
	1819	2146	2.1 E
21 Th	0049	0352	2.3 F
	0702	1041	2.2 E
	1343	1638	1.7 F
	1912	2232	2.1 E
22 F	0139	0450	2.3 F
	0752	1131	2.3 E
	1438	1733	1.8 F
	2002	2315	2.1 E
23 Sa	0227	0536	2.4 F
	0839	1218	2.3 E
	1527	1816	1.8 F
	2047	2355	2.1 E
24 Su	0313	0614	2.5 F
	0924	1301	2.2 E
	1612	1850	1.7 F
	2131		
25 M		0028	2.0 E
	0356	0649	2.4 F
	1006	1337	2.2 E
●	1653	1920	1.7 F
	2212		
26 Tu		0059	2.0 E
	0437	0724	2.4 F
	1047	1403	2.1 E
	1734	1954	1.6 F
	2254		
27 W		0132	1.9 E
	0516	0802	2.3 F
	1127	1420	2.0 E
	1815	2031	1.6 F
	2335		
28 Th		0208	1.9 E
	0556	0843	2.2 F
	1208	1448	2.0 E
	1857	2113	1.6 F
29 F	0018	0247	1.8 E
	0639	0926	2.1 F
	1248	1523	2.0 E
	1939	2157	1.6 F
30 Sa	0101	0329	1.8 E
	0725	1012	2.0 F
	1328	1603	2.0 E
	2021	2242	1.7 F
31 Su	0146	0414	1.8 E
	0814	1058	2.0 F
	1407	1646	2.0 E
	2101	2327	1.8 F

Time meridian 75° W. 0000 is midnight. 1200 is noon.

TABLE 2 – CURRENT DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	Meter Depth	POSITION		TIME DIFFERENCES				SPEED RATIOS		AVERAGE SPEEDS AND DIRECTIONS							
			Latitude	Longitude	Min. before Flood	Flood	Min. before Ebb	Ebb	Flood	Ebb	Minimum before Flood		Maximum Flood		Minimum before Ebb		Maximum Ebb	
		ft	**North**	**West**	h m	h m	h m	h m			knots	Dir.	knots	Dir.	knots	Dir.	knots	Dir.
	NASSAU SOUND Time meridian, 75° W				**on Miami Harbor Entrance, p.72**													
7926	Midsound, 1 mi. N of Sawpit Creek entrance		30° 31.4’	81° 27.1’	+0 01	–0 24	–0 14	–0 30	0.9	1.1	0.0	– –	1.7	312°	0.0	– –	1.7	135°
7931	South Amelia River, off Walker Creek		30° 32.2’	81° 27.9’	–1 09	–0 21	–0 39	–2 06	0.8	0.9	0.0	– –	1.4	341°	0.0	– –	1.4	162°
7936	Nassau River, SW of Mesa Marsh		30° 32.0’	81° 28.8’	+0 08	–0 21	0 00	–0 22	0.8	1.1	0.0	– –	1.5	294°	0.0	– –	1.7	129°
7941	Ft. George River		30° 27.4’	81° 27.1’	–1 36	–1 20	–1 25	–2 29	0.2	0.6	0.0	– –	0.3	334°	0.0	– –	0.9	162°
	ST. JOHNS RIVER				**on St. Johns River Entrance, p.68**													
7946	St. Johns Point, 5 miles east of		30° 23.5’	81° 18.0’	See table 5.													
7951	ST. JOHNS RIVER ENT. (between jetties)	16	30° 24.02’	81° 23.15’	*Daily predictions*						0.0	– –	2.0	262°	0.0	– –	2.0	081°
	. . . do.	10	30° 24.02’	81° 23.15’	+0 06	+0 13	–0 04	+0 07	1.0	1.2	0.0	– –	2.0	262°	0.0	– –	2.1	081°
	. . . do.	30	30° 24.02’	81° 23.15’	–0 19	+0 01	–0 02	+0 07	0.9	0.9	0.0	– –	1.9	262°	0.0	– –	1.9	080°
7956	Mayport Basin Entrance	9	30° 23.82’	81° 23.93’	–0 02	–0 08	+0 01	+0 33	0.6	0.7	0.1	179°	1.2	255°	0.0	– –	1.4	093°
	. . . do.	15	30° 23.82’	81° 23.93’	–0 12	+0 17	+0 11	+0 07	0.7	0.6	0.0	– –	1.3	251°	0.1	166°	1.2	087°
	. . . do.	32	30° 23.82’	81° 23.93’	+0 24	+0 48	+0 17	+0 34	0.6	0.3	0.1	333°	1.2	247°	0.1	164°	0.6	069°
7961	Mayport	7	30° 23.6’	81° 26.0’	+0 06	+1 02	+0 15	–0 04	1.1	1.6	0.0	– –	2.2	211°	0.0	– –	3.3	026°
	. . . do.	17	30° 23.6’	81° 26.0’	–0 03	+0 38	+0 12	+0 05	1.1	1.3	0.0	– –	2.2	211°	0.0	– –	2.6	026°
	. . . do.	27	30° 23.6’	81° 26.0’	–0 27	+0 26	+0 15	+0 14	0.9	0.9	0.0	– –	1.7	211°	0.0	– –	1.8	026°
7966	Mile Point, southeast of	7	30° 22.9’	81° 26.7’	+0 06	+0 38	+0 48	+0 44	1.5	1.6	0.0	– –	3.0	241°	0.0	– –	3.2	073°
	. . . do.	18	30° 22.9’	81° 26.7’	–0 12	+0 38	+0 54	+0 56	1.2	1.2	0.0	– –	2.5	241°	0.0	– –	2.5	073°
	. . . do.	29	30° 22.9’	81° 26.7’	–0 42	+0 38	+1 00	+0 38	1.1	0.9	0.0	– –	2.3	241°	0.0	– –	1.8	073°
7971	ICW Intersection	10	30° 23.02’	81° 27.52’	+0 27	+0 29	+0 08	+0 58	0.8	1.3	0.2	217°	1.6	293°	0.4	003°	2.6	125°
	. . . do.	16	30° 23.02’	81° 27.52’	+0 22	+0 31	+0 10	+0 49	0.8	1.2	0.2	213°	1.6	293°	0.3	007°	2.4	113°
	. . . do.	29	30° 23.02’	81° 27.52’	+0 09	+0 35	+0 10	+0 21	0.8	1.0	0.1	200°	1.5	294°	0.2	020°	2.1	099°
7976	Pablo Creek bascule bridge <40>	3	30° 19.4’	81° 26.3’	–0 14	–0 18	+0 49	+0 59	1.7	2.5	0.0	– –	3.4	180°	0.0	– –	5.2	000°
7981	Sisters Creek entrance (bridge)	4	30° 23.4’	81° 27.7’	–3 30	–3 14	–2 13	–2 34	0.8	0.8	0.0	– –	1.6	000°	0.0	– –	1.6	180°
	. . . do.	10	30° 23.4’	81° 27.7’	–3 36	–3 04	–2 07	–2 34	0.6	0.6	0.0	– –	1.2	000°	0.0	– –	1.2	180°
7986	St. Johns Bluff	7	30° 23.4’	81° 29.5’	+0 30	+1 21	–0 18	+1 02	0.8	1.2	0.0	– –	1.6	244°	0.0	– –	2.4	059°
	. . . do.	17	30° 23.4’	81° 29.5’	+0 18	+1 03	+0 30	+1 02	0.9	1.0	0.0	– –	1.7	244°	0.0	– –	2.0	059°
	. . . do.	26	30° 23.4’	81° 29.5’	–0 12	+0 33	+0 24	+1 14	0.8	0.8	0.0	– –	1.6	244°	0.0	– –	1.6	059°
7991	Blount Island, East of	7	30° 23.52’	81° 30.51’	+1 21	+1 08	+0 49	+1 54	0.7	1.1	0.2	000°	1.5	275°	0.2	183°	2.3	079°
	. . . do.	16	30° 23.52’	81° 30.51’	+0 54	+0 58	+1 04	+1 43	0.7	0.8	0.2	011°	1.4	270°	0.1	168°	1.7	090°
	. . . do.	30	30° 23.52’	81° 30.51’	+0 33	+1 08	+1 12	+1 32	0.5	0.6	0.1	183°	1.1	264°	0.0	– –	1.3	099°
7996	Dames Point Bridge	5	30° 23.08’	81° 33.28’	+1 52	+1 39	+1 28	+2 14	0.6	0.9	0.1	345°	1.2	254°	0.2	155°	1.9	080°
	. . . do.	14	30° 23.08’	81° 33.28’	+1 30	+1 29	+1 32	+2 07	0.7	0.9	0.1	343°	1.4	257°	0.0	– –	1.8	073°
	. . . do.	28	30° 23.08’	81° 33.28’	+1 15	+2 00	+2 01	+2 14	0.6	0.7	0.1	160°	1.2	254°	0.0	– –	1.4	073°
8001	Drummond Point, channel south of	7	30° 24.55’	81° 36.17’	+1 51	+2 32	+2 44	+3 00	0.7	0.8	0.0	– –	1.4	241°	0.0	– –	1.7	060°
	. . . do.	17	30° 24.55’	81° 36.17’	+1 34	+2 35	+2 51	+3 01	0.7	0.7	0.0	– –	1.3	222°	0.0	– –	1.4	061°
	. . . do.	27	30° 24.55’	81° 36.17’	+1 21	+2 20	+2 46	+2 51	0.6	0.5	0.0	– –	1.2	243°	0.0	– –	1.1	057°
8006	Trout River Cut	6	30° 23.03’	81° 37.69’	+2 31	+2 48	+2 32	+2 52	0.7	0.7	0.1	277°	1.3	193°	0.1	280°	1.5	005°
	. . . do.	15	30° 23.03’	81° 37.69’	+2 19	+2 53	+2 42	+2 52	0.6	0.6	0.0	– –	1.1	191°	0.1	107°	1.3	025°
	. . . do.	32	30° 23.03’	81° 37.69’	+1 49	+2 31	+3 02	+2 58	0.6	0.6	0.0	– –	1.2	205°	0.0	– –	1.1	023°
8011	Terminal Channel (north end) <70>	7	30° 21.42’	81° 37.08’	+2 39	+3 16	+3 02	+3 38	0.5	0.6	0.0	– –	1.0	225°	0.0	– –	1.3	001°
	. . . do.	17	30° 21.42’	81° 37.08’	+2 16	+3 06	+3 20	+3 33	0.6	0.5	0.0	– –	1.2	183°	0.0	– –	1.1	001°
	. . . do.	27	30° 21.42’	81° 37.08’	+1 51	+3 28	+3 16	+3 23	0.5	0.3	0.0	– –	1.0	185°	0.0	– –	0.7	001°
8016	Commodore Point, terminal channel <70>	7	30° 19.05’	81° 37.58’	+2 39	+3 28	+3 10	+3 37	0.5	0.5	0.0	– –	0.9	197°	0.0	– –	1.0	072°
	. . . do.	17	30° 19.05’	81° 37.58’	+2 12	+3 13	+3 23	+3 25	0.5	0.4	0.0	– –	1.0	221°	0.0	– –	0.9	051°
	. . . do.	27	30° 19.05’	81° 37.58’	+1 43	+2 30	+3 38	+3 08	0.6	0.4	0.0	– –	1.1	221°	0.0	– –	0.8	035°
8021	Jacksonville, off Washington St <70>	6	30° 19.3’	81° 39.2’	+1 48	+3 03	+3 12	+3 26	1.2	0.9	0.0	– –	2.4	281°	0.0	– –	1.8	118°
	. . . do.	15	30° 19.3’	81° 39.2’	+1 48	+2 57	+3 12	+3 20	1.0	0.8	0.0	– –	2.0	281°	0.0	– –	1.6	118°
	. . . do.	24	30° 19.3’	81° 39.2’	+1 48	+2 33	+3 12	+3 38	1.0	0.7	0.0	– –	1.9	281°	0.0	– –	1.4	118°
8026	Jacksonville, F.E.C. RR. bridge <70>	7	30° 19.3’	81° 39.9’	+1 48	+3 21	+3 30	+3 20	1.0	0.8	0.0	– –	2.0	240°	0.0	– –	1.6	060°
	. . . do.	15	30° 19.3’	81° 39.9’	+1 48	+3 03	+3 24	+3 26	0.9	0.6	0.0	– –	1.8	240°	0.0	– –	1.3	060°
	. . . do.	24	30° 19.3’	81° 39.9’	+1 48	+3 15	+3 24	+3 14	0.7	0.5	0.0	– –	1.3	240°	0.0	– –	1.0	060°
8031	Winter Point <70>	7	30° 18.5’	81° 40.5’	+1 54	+3 33	+4 30	+3 44	0.6	0.5	0.0	– –	1.2	200°	0.0	– –	1.0	015°
	. . . do.	14	30° 18.5’	81° 40.5’	+1 54	+3 03	+4 24	+3 38	0.6	0.5	0.0	– –	1.1	200°	0.0	– –	1.0	015°
	. . . do.	22	30° 18.5’	81° 40.5’	+1 54	+3 57	+4 36	+3 56	0.4	0.4	0.0	– –	0.8	200°	0.0	– –	0.8	015°

Endnotes can be found at the end of table 2.

TABLE 2 – CURRENT DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	Meter Depth	POSITION		TIME DIFFERENCES				SPEED RATIOS		AVERAGE SPEEDS AND DIRECTIONS							
			Latitude	Longitude	Min. before Flood	Flood	Min. before Ebb	Ebb	Flood	Ebb	Minimum before Flood		Maximum Flood		Minimum before Ebb		Maximum Ebb	
		ft	**North**	**West**	h m	h m	h m	h m			knots	Dir.	knots	Dir.	knots	Dir.	knots	Dir.
	ST. JOHNS RIVER–cont. Time meridian, 75° W				**on St. Johns River Entrance, p.68**													
8036	Mandarin Point <70>	6	30° 09.3'	81° 41.1'	+3 07	+3 39	+3 24	+3 38	0.3	0.4	0.0	– –	0.6	179°	0.0	– –	0.8	013°
	. . . do.	15	30° 09.3'	81° 41.1'	+3 13	+3 33	+3 24	+3 38	0.3	0.3	0.0	– –	0.6	179°	0.0	– –	0.7	013°
	. . . do.	24	30° 09.3'	81° 41.1'	+2 48	+3 33	+3 24	+3 32	0.3	0.3	0.0	– –	0.5	179°	0.0	– –	0.5	013°
8041	Red Bay Point, draw bridge <70>	4	29° 59.1'	81° 37.8'	+2 48	+3 57	+5 24	+4 02	0.5	0.3	0.0	– –	0.9	115°	0.0	– –	0.6	300°
	. . . do.	6	29° 59.1'	81° 37.8'	+2 42	+3 57	+5 18	+4 08	0.5	0.3	0.0	– –	0.9	115°	0.0	– –	0.5	300°
	. . . do.	14	29° 59.1'	81° 37.8'	+2 48	+3 57	+5 30	+4 08	0.4	0.2	0.0	– –	0.8	115°	0.0	– –	0.4	300°
8046	Tocoi to Lake George		– – –	– – –	Current weak and variable													
	FLORIDA COAST				**on Miami Harbor Entrance, p.72**													
8051	Ft. Pierce Inlet		27° 28.3'	80° 17.5'	+1 19	+0 39	+0 48	+0 35	1.5	2.0	0.0	– –	2.6	250°	0.0	– –	3.1	072°
8056	Lake Worth Inlet (between jetties)		26° 46.33'	80° 02.13'	+0 13	–0 07	–0 01	0 00	1.3	2.3	0.0	– –	2.4	273°	0.0	– –	3.6	094°
8061	Fort Lauderdale, New River		26° 06.73'	80° 07.18'	–0 43	–0 39	–0 06	–0 16	0.4	0.3	0.0	– –	0.8	005°	0.0	– –	0.5	130°
	PORT EVERGLADES																	
8066	Pier 2, 1.3 miles east of <41>		26° 05.63'	80° 05.78'	– – –	– – –	– – –	– – –	– –	– –	0.0	– –	0.2	– –	0.0	– –	0.4	– –
8071	Entrance (between jetties)		26° 05.58'	80° 06.32'	–0 08	–0 49	–0 43	–0 34	0.3	0.4	0.0	– –	0.6	275°	0.0	– –	0.7	095°
8076	Entrance from southward (canal)		26° 05.2'	80° 06.9'	+0 40	+0 07	+0 31	–0 09	0.7	1.1	0.0	– –	1.3	167°	0.0	– –	1.7	358°
8081	Turning Basin		26° 05.70'	80° 07.05'	–1 01	–1 07	–1 02	–1 11	0.1	0.3	0.0	– –	0.2	320°	0.0	– –	0.5	155°
8086	Turning Basin, 300 yards north of		26° 05.8'	80° 07.1'	–0 20	–1 09	–0 27	–0 14	0.5	1.1	0.0	– –	0.9	349°	0.0	– –	1.8	160°
8091	17th Street Bridge		26° 06.02'	80° 07.13'	–0 38	–0 53	–0 28	–0 55	1.1	1.2	0.0	– –	1.9	350°	0.0	– –	1.9	170°
	MIAMI HARBOR																	
8096	Bakers Haulover Cut		25° 54.0'	80° 07.4'	–0 01	+0 07	+0 14	–0 17	1.6	1.6	0.0	– –	2.9	270°	0.0	– –	2.5	090°
	Government Cut																	
8101	East entrance, off north jetty	13d	25° 45.59'	80° 07.35'	–0 02	–0 19	–0 08	–0 26	0.4	0.9	0.3	157°	0.6	236°	0.1	317°	1.5	092°
8106	East entrance, inside south jetty	13d	25° 45.61'	80° 07.66'	–0 07	–0 06	–0 04	0 00	1.2	1.1	0.2	055°	2.1	343°	0.4	052°	1.8	116°
8111	Midway, north side	13d	25° 45.84'	80° 07.96'	–0 12	–0 03	–0 07	–0 08	0.7	0.5	– –	– –	1.2	292°	– –	– –	0.7	108°
	. . . do.	28d	25° 45.84'	80° 07.96'	–0 11	–0 05	–0 10	–0 06	0.4	0.3	– –	– –	0.7	288°	– –	– –	0.4	104°
8116	MIAMI HARBOR ENTRANCE	16d	25° 45.90'	80° 08.17'	*Daily predictions*						– –	– –	1.8	293°	– –	– –	1.6	112°
	. . . do.	31d	25° 45.90'	80° 08.17'	+0 01	–0 02	–0 02	+0 02	0.8	1.0	– –	– –	1.4	298°	– –	– –	1.6	104°
8121	West entrance, south side	15d	25° 45.85'	80° 08.25'	+0 09	+0 10	–0 04	+0 01	0.9	1.6	0.1	010°	1.6	288°	– –	– –	2.5	100°
	Main Channel																	
8126	Causeway Is., 0.2 mi. SE of <65>	13d	25° 46.06'	80° 08.58'	+0 01	+0 23	–0 01	–0 14	0.8	0.4	0.1	044°	1.4	306°	0.2	222°	0.7	131°
8131	Lummus Is., northeast corner <66>	13d	25° 46.02'	80° 08.70'	–0 07	–0 02	+0 06	–0 04	0.1	0.4	– –	– –	0.2	265°	– –	– –	0.7	104°
8136	Dodge Is., 0.1 mi. off NW corner	12d	25° 46.89'	80° 10.90'	+0 17	–0 14	+0 01	+0 04	0.2	0.3	– –	– –	0.4	277°	– –	– –	0.4	093°
	. . . do.	26d	25° 46.89'	80° 10.90'	+0 12	–0 32	+0 14	+0 20	0.2	0.2	– –	– –	0.3	276°	– –	– –	0.3	091°
	Fishermans Channel																	
8141	Fisher Is., 0.2 mi. NW of	15d	25° 45.87'	80° 09.08'	+0 14	+0 38	+0 17	+0 39	0.6	0.7	– –	– –	1.0	280°	0.1	014°	1.1	090°
8146	Lummus Is., 0.15 mi. off SW corner	15d	25° 45.89'	80° 09.69'	+0 20	–0 20	+0 10	+0 22	0.3	0.6	– –	– –	0.6	271°	– –	– –	0.9	095°
8151	West end, SW of Dodge Island	11d	25° 46.36'	80° 10.74'	–0 05	–0 32	–0 15	–0 21	0.1	0.2	0.1	002°	0.2	277°	– –	– –	0.3	089°
8156	Miami River entrance	10d	25° 46.21'	80° 11.23'	+0 15	–0 02	–0 01	+0 46	0.1	0.4	– –	– –	0.2	261°	– –	– –	0.6	071°
8161	Fowey Rocks Light, 1.5 miles SW of		25° 35'	80° 07'	See table 5.													
	FLORIDA REEFS to MIDNIGHT PASS				**on Key West, p.76**													
8166	Caesar Creek, Biscayne Bay		25° 23.2'	80° 13.6'	+0 07	–0 08	–0 14	–0 05	1.2	1.0	0.0	– –	1.2	316°	0.0	– –	1.8	123°
8171	Long Key, drawbridge east of		24° 50.4'	80° 46.2'	+0 58	+1 27	+2 21	+1 33	1.1	0.7	0.0	– –	1.1	000°	0.0	– –	1.2	202°
8176	Long Key Viaduct		24° 48.1'	80° 51.9'	+1 34	+1 28	+2 02	+1 57	0.9	0.7	0.0	– –	0.9	349°	0.0	– –	1.2	170°
8181	Moser Channel, swingbridge		24° 42.0'	81° 10.2'	+1 07	+1 30	+1 50	+1 47	1.4	1.0	0.0	– –	1.4	339°	0.0	– –	1.8	166°
8186	Bahia Honda Harbor, bridge		24° 39.4'	81° 17.3'	+1 01	+0 39	+1 53	+1 05	1.4	1.2	0.0	– –	1.4	004°	0.0	– –	2.1	182°
8191	No Name Key, northeast of		24° 42.3'	81° 18.8'	+0 55	+1 24	+1 20	+0 53	0.7	0.5	0.0	– –	0.7	312°	0.0	– –	0.9	142°

Endnotes can be found at the end of table 2.

APPENDIX C. Notice-to-Mariners issued on December 15, 1998

NOTICE TO MARINERS

Issued By:

CENTER FOR OPERATIONAL OCEANOGRAPHIC PRODUCTS & SERVICES

DEPARTMENT OF COMMERCE
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

ST. JOHNS RIVER, FLORIDA

During the summer of 1998, the Center for Operational Oceanographic Products and Services (CO-OPS) conducted a Tidal Current Survey in the St. Johns River, Florida. Significant changes have occurred in the river channels since the original 1934, and 1958 Circulation Surveys. The reference station – St. Johns River Entrance – was re-occupied and data was collected at five additional secondary locations in the St. Johns River. These new secondary locations were selected in cooperation with local authorities. Previously published average correction factors for 16 secondary stations were re-evaluated based on their separate depths and referred to the new reference station data. Five additional tide locations were also occupied during the survey.

This data was not available in time for inclusion in the 1999 editions of the official National Ocean Service (NOS) Tidal Current Tables 1999 – Atlantic Coast of North America and Tide Tables 1999 – East Coast of North and South America Including Greenland. Copies of the new 1999 daily Predictions for St. Johns River entrance and the new Table2 correction factors for both the currents and tides will be available on the CO-OPS web page – <http://www.OPSD.nos.noaa.gov>.

A complete technical report on the St. Johns River Tidal Current Survey is scheduled for release by NOS during the first quarter of 1999.

Copies of the 1999 Daily Current Predictions for St. Johns River Entrance based on the new constituents and the revised Table 2 corrections for secondary stations for both currents and tides are attached.

(Issued December 15, 1998)