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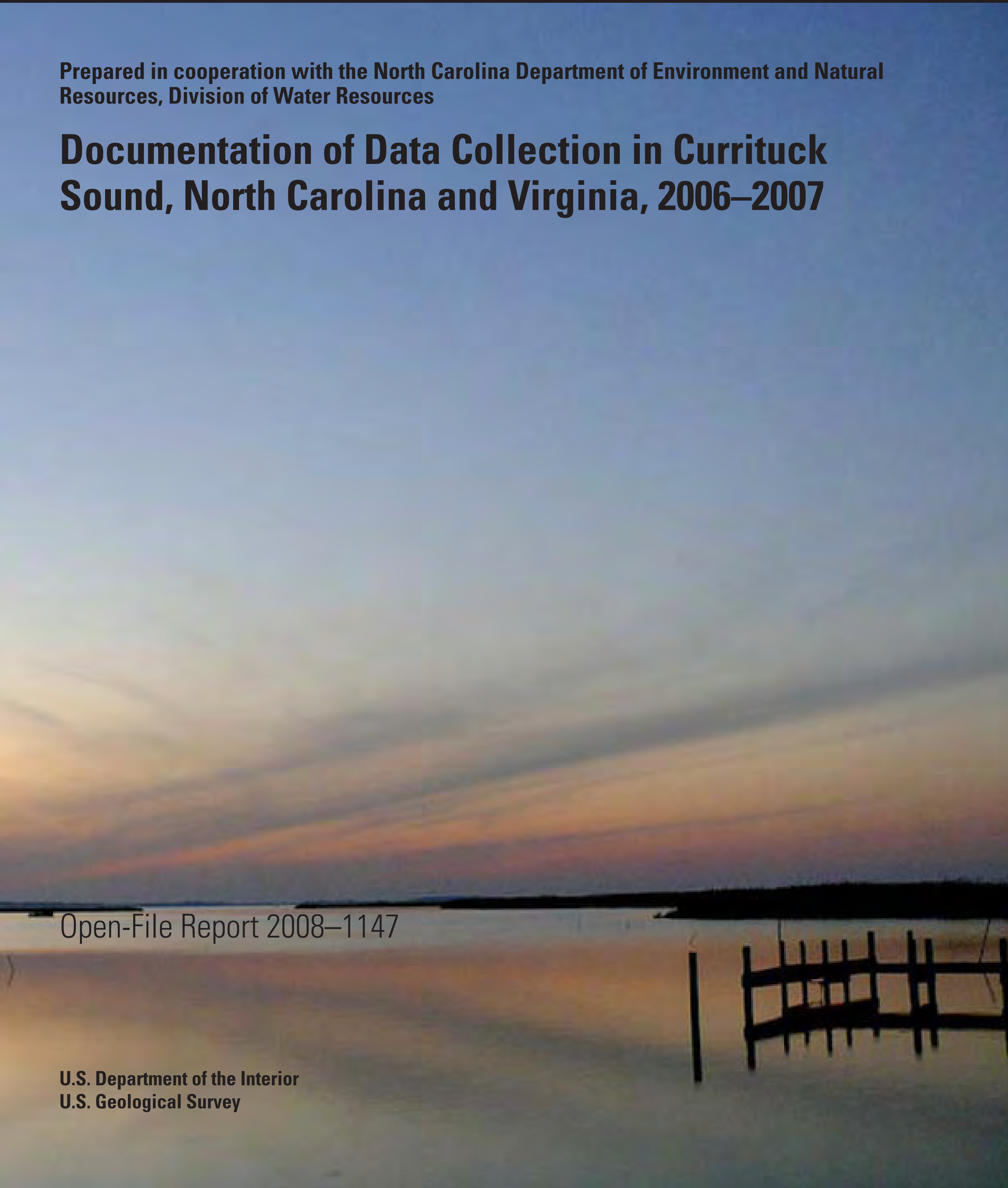
Documentation of Data Collection in Currituck Sound, North Carolina and Virginia, 2006–2007



Open-File Report 2008–1147

U.S. Department of the Interior
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Cover. Currituck Sound at sunset, November 18, 2007, looking west across the sound *(photograph used with permission by Damien P. Ossi).*

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By Jason M. Fine

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
	Area	
square foot (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Abbreviations and Acronyms:

ADVM	acoustic Doppler velocity meter
AIWW	Atlantic Intracoastal Waterway
DWR	Division of Water Resources
ECSU	Elizabeth City State University
FNU	Formazin Nephelometric Unit
FWS	U.S. Fish and Wildlife Service
IMS	The University of North Carolina at Chapel Hill Institute of Marine Sciences
NERR	North Carolina National Estuarine Research Reserve
NWIS	National Water Information System
NWQL	National Water Quality Laboratory
RM	river mile
SAV	submerged aquatic vegetation
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

Documentation of Data Collection in Currituck Sound, North Carolina and Virginia, 2006–2007

By Jason M. Fine

Abstract

During 2006 and 2007, scientists from Elizabeth City State University, North Carolina Estuarine Research Reserve, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey collected hydrologic and water-quality data at nine sites in and around Currituck Sound. Hydrologic and water-quality data were collected at five tributary sites—the Northwest River near Moyock, Tull Creek near Currituck, and Intracoastal Waterway near Coinjock in North Carolina, and the Albemarle and Chesapeake Canal near Princess Anne, and the North Landing River near Creeds in Virginia. In addition, data were collected at one site at the mouth of Currituck Sound (Currituck Sound at Point Harbor, North Carolina). Only water-quality data were collected at three sites in Currituck Sound and Back Bay—Currituck Sound near Jarvisburg, and Upper Currituck Sound near Corolla in North Carolina, and Back Bay near Back Bay in Virginia. The hydrologic data included water elevation and velocity, and discharge. The water-quality data included discrete samples and continuous measurements of water temperature, specific conductance, dissolved oxygen, pH, turbidity, and chlorophyll *a*. The hydrologic and water-quality data collected for this study were quality assured by the U.S. Geological Survey and stored in the National Water Information System database.

The data collected for this project are being used to develop an unsteady multidimensional hydrodynamic and water-quality model of Currituck Sound by the U.S. Army Corps of Engineers. The purpose of this model is to provide the basis for planning and the development of best-management practices and restoration projects for Currituck Sound and its tributaries.

Introduction

Ecological conditions in and around Currituck Sound in northeastern North Carolina and southeastern Virginia have changed noticeably since at least the 1980s. Fish-population surveys have indicated a decrease in freshwater species and an increase in estuarine species. These changes are attributed to an increase in salinity in the sound (Southwick and Norman, 1991). It is further hypothesized (U.S. Army Corps of Engineers, 2001) that the change in the salinity regime is associated with a substantial decline in submerged aquatic vegetation (SAV), although other factors may be responsible for the SAV declines. Beds of SAV provide food for migratory waterfowl, in addition to spawning and nursery habitats for fish species. A decline in SAV beds also contributes to a decline in water quality in that a decrease in SAV root systems and underwater biomass allows increased resuspension of fine sediments and associated nutrients during wind events (U.S. Army Corps of Engineers, 2001).

Changes in salinity in Currituck Sound could be associated with droughts, ocean overwash, previous pumping of sea water into Back Bay, reduction of freshwater inflows, and transport of high-salinity waters between the sound and Chesapeake Bay to the north and the sound and Albemarle Sound to the south during wind events and tidal fluctuations (fig. 1; U.S. Army Corps of Engineers, 2001). Great Bridge Lock at the western end of Albemarle and Chesapeake Canal and 21 river miles (RMs) north of the Virginia and North Carolina State line prevents continuous inflow of high-salinity water from Elizabeth River into the canal and, thus, into Currituck Sound (fig. 1). Data collected during 1998–99 indicate, however, that Elizabeth River may be a source of salt to Currituck Sound (Caldwell, 2001). About 14 RMs south of the State line, the Atlantic Intracoastal Waterway (AIWW) is routed through a land cut near Coinjock to the head of North River (fig. 1), where the AIWW continues south through North River to Albemarle Sound, another potential source of high-salinity water to Currituck Sound.

No major point-source dischargers are in the Currituck Sound basin (North Carolina Department of Environment and Natural Resources, 2002). Nonpoint-source drainage to Tull Creek was identified in 1992–93 as the primary source of phosphorus and nitrogen to Currituck Sound. At that time, Back Bay was considered to be the second greatest source of nitrogen to Currituck Sound. In addition, Northwest River and North Landing River contribute high concentrations of phosphorus to the sound (North Carolina Division of Environment, Health, and Natural Resources, 1994). Jean Guite Creek, which flows to the north on the southeast side of the sound

Figure 1. Locations of Currituck Sound and hydrologic and water-quality data-collection sites in North Carolina and Virginia, 2006–2007.

(east of site 24, fig. 1), drains Southern Shores and parts of Kitty Hawk, and also may be a source of some nitrogen inputs to the sound.

In 2001, the U.S. Army Corps of Engineers (USACE) conducted a reconnaissance study of Currituck Sound under Section 905(b) of the Water Resources Development Act of 1986. The purpose of the study was “to determine whether planning for the improvement of water quality, environmental restoration and protection, and related purposes for Currituck Sound should proceed further” (U.S. Army Corps of Engineers, 2001). Among other things, one of the conclusions from the study was that Currituck Sound is a “threatened resource,” and that a hydrodynamic model was needed to evaluate the water and salt balance in the sound. Federal, State, and local government agencies subsequently concluded that a water-quality model, coupled with the hydrodynamic model, was needed to “assess the effect of management strategies on the sound’s water chemistry, quality, and resource viability.” Data collection to support model development and testing also was recommended.

In 2005, a team of scientists was assembled to begin an investigation of the hydrologic and water-quality characteristics of Currituck Sound and its major tributaries. The objectives of the investigation were to document water-quality trends in the sound and collect the data needed for the development of the coupled hydrodynamic and water-quality model. The project partners for the study included the Division of Water Resources (DWR) of the North Carolina Department of Environment and Natural Resources, which funded much of the hydrologic and water-quality data collection and provided project oversight; Elizabeth City State University (ECSU), North Carolina National Estuarine Research Reserve (NERR), and the U.S. Fish and Wildlife Service (FWS), all of which were responsible for water-quality data collection; the USACE, which was charged in the development of an unsteady, multidimensional hydrodynamic and water-quality model of the sound and provided overall project management; The University of North Carolina at Chapel Hill Institute of Marine Sciences (IMS), which provided laboratory analyses of water-quality samples; and the U.S. Geological Survey (USGS), which provided for hydrologic data collection, water-quality data-collection oversight and quality assurance, data processing and storage, and watershed modeling.

Purpose and Scope

The purpose of this report is to document the data-collection efforts of the USGS and its project partners in and around Currituck Sound during 2006 and 2007. Data were collected at nine locations in the study area from January 2006 to September 2007 and include more-or-less continuous measurements of water elevation, velocity, discharge, water temperature, specific conductance, dissolved oxygen, pH, turbidity, and chlorophyll *a* at a subset of the nine sites. Water-quality samples also were collected at selected sites in the sound.

This report describes the sites and the methods used for data collection, quality assurance, and archiving. The data collected for this project are being used by the USACE in the development of an unsteady, multidimensional hydrodynamic and water-quality model of the sound.

Study Area

Currituck Sound is a 97,852-acre (153 square mile (mi^2)) oligohaline estuary in the northeastern part of the Coastal Plain Physiographic Province of North Carolina (fig. 1). Back Bay, which is north of Currituck Sound, covers an area of about 26,000 acres (41 mi^2) in the southeastern part of the Coastal Plain Physiographic Province of Virginia (fig. 1). The drainage area of the entire Currituck Sound is estimated to be 733 mi^2, of which almost one-third is open water. Most of the land that drains to Currituck Sound is in the cities of Virginia Beach and Chesapeake, Virginia, and in northwest Currituck County in North Carolina. Because the flow in several canals that connect Currituck Sound to Chesapeake Bay can move northward or southward and because of the low topographic relief in the basin, the exact identification of the drainage area of Currituck Sound is uncertain.

The climate of the study area is temperate and oceanic. The average annual precipitation is about 45 inches (in.), and monthly totals typically are greatest during July and August (Norman, 1991). Flood-producing rainfalls and high winds associated with hurricanes or tropical storms and(or) convective thunderstorms generally occur during the summer or fall. In addition, nor’easters are storms that generate strong winds, heavy rainfalls, and high water elevations or flooding and generally occur during fall and winter months.

Three major tributaries supply most of the freshwater to Currituck Sound—North Landing River, Northwest River, and Tull Creek (fig. 1). Northwest River and Tull Creek drain mostly agricultural lands and have drainage areas of 196 mi^2 and 52 mi^2, respectively. The drainage area of North Landing River at the Virginia-North Carolina State line is about 117 mi^2. The North Landing River is channelized over its entire length, as a part of the AIWW, and joins the Albemarle and Chesapeake Canal about 12 RMs north of the State line. Great Bridge Lock, is at the western end of the Albemarle and Chesapeake Canal and about 21 RMs from the Virginia-North Carolina State line (fig. 1).

From Great Bridge Lock, the AIWW extends east through the Albemarle and Chesapeake Canal and south through the North Landing River and into Currituck Sound. About 14 RMs south of the Virginia-North Carolina State line, the AIWW is routed through a land cut near Coinjock to the confluence of North River where the AIWW continues south through the North River, parallel to Currituck Sound, to the confluence with Albemarle Sound (fig. 1).

Data Collection

Data for this study were collected at nine sites in and around Currituck Sound (fig. 1; table 1). Data collection began in January 2006 and continued through September 2007. A few gaps occurred in the continuous-data record because of instrumentation failure or fouling of sensors (fig. 2). Water-quality samples were collected biweekly during typically warmer months (April through October) and monthly during typically colder months (November through March). This section describes the type of data collected, the methods used to collect the data, quality-assurance procedures, and data archival.

Water Elevation, Water Velocity, and Discharge

Water elevation and velocity were measured at sites 4, 5, 6, 7, 20, and 24 using acoustic Doppler velocity meters (ADVMs; fig. 1). Data were logged at 15-minute intervals to a data-collection platform and transmitted by satellite to the USGS National Water Information System (NWIS) database. Water-elevation (stage) data were collected by a pressure transducer in the ADVM using techniques described in Freeman and others (2004). The data were recorded to an accuracy of 0.01 foot (ft) and were referenced to North American Vertical Datum of 1988 (NAVD 88) using a differential global positioning system or nearby benchmarks.

The ADVM measures water velocity by the way of transducers that send and receive acoustic pulses. An acoustic pulse of a known frequency is sent into the water column along an acoustic beam. A portion of the acoustic pulse is reflected back to the transducer at a frequency that has been shifted because of the Doppler effect. An index velocity is determined by the change in the acoustic frequency and the geometric configuration of the transducers (SonTek Corporation, 2000). Details on the theory and operation of the ADVM system were documented by Morlock and others (2002) and Ruhl and Simpson (2005).

River discharge can be computed as

$$Q = VA, \quad (1)$$

where,

Q is discharge, in cubic feet per second;
V is mean velocity at a specified channel cross section, in feet per second; and
A is channel area for a specified cross section, in square feet.

Channel area for a river can be determined by surveying a cross section. To account for the change in cross sectional area over a range of stages, a stage-area rating is developed by computing the channel area for a range of river stages. To compute cross-sectional mean velocities from ADVM-measured velocities, the relation between mean channel velocity and ADVM-measured velocities must be established. The method used to relate mean velocity and ADVM-measured velocity is referred to as the index-velocity method. The ADVM measures velocity in a part of the stream, and the measured velocity is used to estimate, or index, the mean channel velocity.

To establish the relations between mean channel velocity and ADVM velocity, discharge measurements were made near the gaging stations with an acoustic Doppler current profiler while the ADVM's were measuring velocity. Mean velocities were derived for each individual discharge measurement by dividing the measured discharge by the channel area computed from the stage-area ratings. Each discharge measurement

Table 1. Description of data-collection sites in and around Currituck Sound in North Carolina and Virginia, 2006–2007.

[USGS, U.S. Geological Survey; ~, approximately]

Site number (fig. 1)	USGS station number	Site name	Latitude	Longitude	Mean channel width (feet)	Mean water depth (feet)
4	02043410	Northwest River above mouth near Moyock, NC	36°30'44"	76°05'12"	477	8.2
5	02043415	Tull Creek at SR 1222 near Currituck, NC	36°29'47"	76°05'03"	219	7.6
6	0204343500	Intracoastal Waterway at Coinjock, NC	36°20'34"	75°57'15"	181	19.1
7	02043120	Albemarle and Chesapeake Canal near Princess Anne, VA	36°43'04"	76°06'02"	226	10.1
14/15	02043460	Currituck Sound off Dews Island near Jarvisburg, NC	36°12'39"	75°48'20"	~21,000	4.9[a]
20	02043270	North Landing River near Creeds, VA	36°36'58"	76°02'57"	422	10.6
21	02043016	Back Bay below Ragged Island near Back Bay, VA	36°37'03"	75°56'31"	~23,000	6.9[a]
23	02043430	Upper Currituck Sound near Corolla, NC	36°23'43"	75°50'33"	~23,500	3.0[a]
24	0204347500	Currituck Sound at US 158 nr Point Harbor, NC	36°05'12"	75°46'06"	~14,000	9.0[a]

[a]Water depth at the water-quality monitoring site.

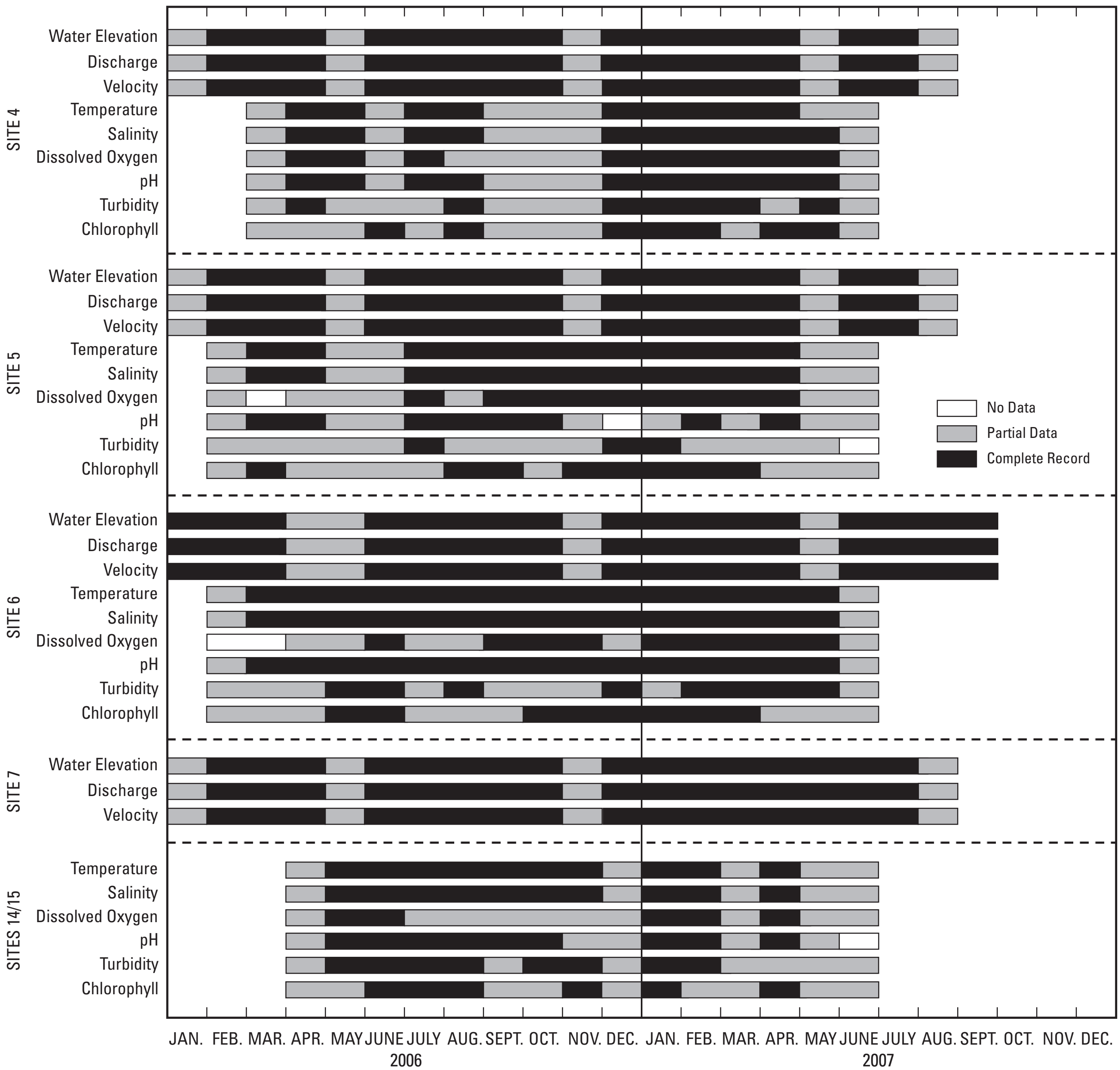

Figure 2. Summary of continuous data collected at study sites in and around Currituck Sound, North Carolina and Virginia, 2006–2007.

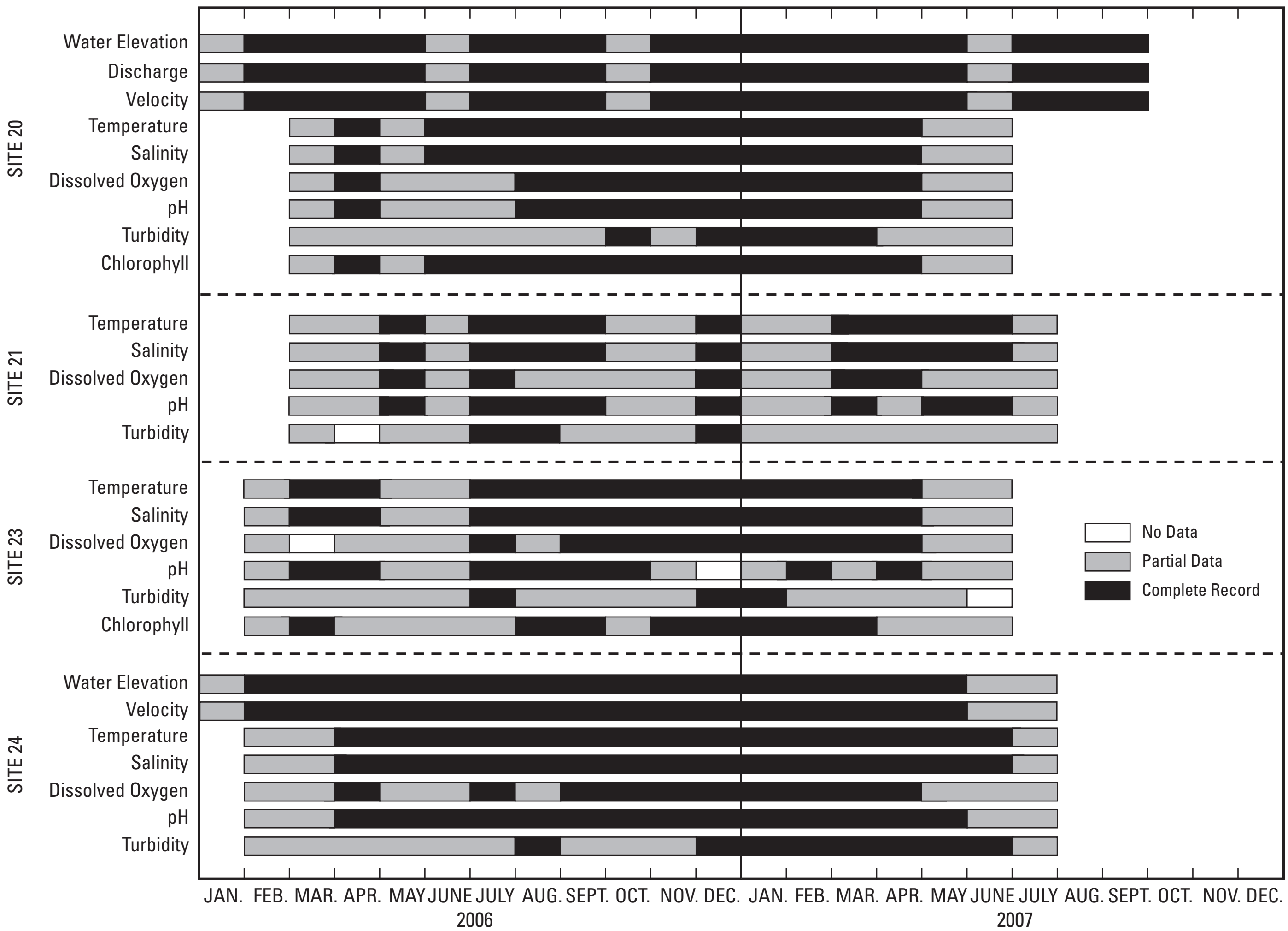

Figure 2 (Continued). Summary of continuous data collected at study sites in and around Currituck Sound, North Carolina and Virginia, 2006–2007.

provided a computed mean channel velocity and an average ADVM velocity. These data then were used to develop an index-velocity rating at each site to compute mean channel velocities from ADVM velocities. Instantaneous discharge was computed using index velocity ratings at sites 4, 5, 6, 7, and 20.

Because of the channel width of Currituck Sound at site 24, the index-velocity method was not used to calculate discharge data. However, water velocity was measured at this site at 0.5-meter intervals through the water column to document velocities at the mouth of the sound.

Continuous Water-Quality Data

Continuous water-quality data were collected and logged at sites 4, 5, 6, 14/15, 20, 21, 23, and 24 using YSI multi-parameter water-quality sondes (table 2; YSI Inc., 2006). Water temperature, specific conductance, dissolved oxygen, ph, and turbidity was measured at a single depth in the water column at each site. Additionally, chlorophyll *a* was measured at sites 4, 5, 6, 14/15, and 20. Each site was visited periodically by the project partners (biweekly from April through October and monthly from November through March) to exchange the dirty sonde with a newly cleaned and calibrated sonde and to retrieve the data. During these site visits, the two sondes (the one being replaced and the replacement sonde) were placed side by side in a bucket of in-situ water to get comparison readings between the dirty sonde and the clean, calibrated sonde. The clean, calibrated sonde then was used to measure a vertical profile of the water column to ensure that the sensor measurements were representative of the local waterbody before deploying the sonde at the site to begin recording data. The dirty sonde was returned to the laboratory for post-calibration processing and downloading the data. The post-calibration processing entailed immersing the dirty sensors in known standards and recording the readings. These readings in conjunction with the values obtained in the side-by-side comparison in the field were used to determine corrections to apply to the data. All data then were sent to the USGS for processing and storage in the NWIS database, and the sondes were cleaned, calibrated, and prepared for the next deployment. These methods, which were used when servicing the water-quality monitors and processing the data, were modified from methods documented by Wagner and others (2006).

All calibrations were done in a stable laboratory environment or similar condition. For water temperature, no calibrations are necessary, but the temperature sensor was compared during each calibration to another thermometer to ensure the accuracy of the sensor. The temperature probes have a range of -5 degrees Celsius (ºC) to 45 ºC and an accuracy of plus or minus (+/-) 0.15 ºC. The specific conductance probes were calibrated to two known standards and checked against a third standard, which bracketed the expected environmental conditions at the deployment site. Specific conductance is the electrical conductivity of water, expressed in units of microsiemens per centimeter at 25 ºC (µS/cm at 25 ºC). The specific conductance probes have a range of 0 to 100,000 µS/cm at 25 ºC and an accuracy of +/- 0.5 percent of the reading. Specific conductance was converted to salinity in the database by using the algorithm given in Miller and others (1988). Dissolved-oxygen sensors were calibrated by using the

Table 2. Description of data collected in and around Currituck Sound in North Carolina and Virginia, 2006–2007.

[NAVD 88, North American Vertical Datum of 1988; IMS, The University of North Carolina at Chapel Hill Institute of Marine Sciences; NWQL, USGS National Water Quality Laboratory; USGS, U.S. Geological Survey; ECSU, Elizabeth City State University; —, no data collected; na, not applicable; FWS, U.S. Fish and Wildlife Service; NEER, North Carolina National Estuarine Research Reserve]

Site number (fig. 1)	Project partner responsible for data collection				Continuous water-quality monitoring probe location (feet above channel bottom)	Number of water-quality samples analyzed by IMS	Number of water-quality samples analyzed by NWQL
	Continuous discharge	Continuous water elevation referenced to NAVD 88	Discrete water-quality samples	Continuous water-quality monitoring			
4	USGS	USGS	ECSU	ECSU	3.0	16	2
5	USGS	USGS	ECSU	ECSU	3.0	16	2
6	USGS	USGS	ECSU	ECSU	5.5	16	1
7	USGS	USGS	USGS	—	na	7	3
14/15	—	—	ECSU	ECSU	1.0	16	2
20	USGS	USGS	ECSU	ECSU	3.0	16	2
21	—	—	USGS	FWS	3.0	8	3
23	—	—	NEER	NEER	1.0	18	3
24	—	USGS	NEER	NEER	3.0	19	3

100 percent air-saturation method and checked for range by using a zero dissolved-oxygen standard. The dissolved-oxygen probes have a range of 0 to 20 milligrams per liter (mg/L) with an accuracy of +/- 2 percent of the reading or 0.2 mg/L, whichever is greater. The pH probes were calibrated by using two known standards that bracketed the expected environmental conditions at the deployment site. The pH probes have a range of 0 to 14 units and an accuracy of 0.01 unit. The turbidity probes were calibrated to two standards—a zero standard (de-ionized water) and a known standard. The turbidity probe has a range of 0 to 1,000 Formazin Nephelometric Units (FNU) and an accuracy of 0.1 FNU. The chlorophyll sensors were calibrated by using two standards—a zero standard (de-ionized water) and a known rhodamine-B dye solution. The chlorophyll sensors have a range of 0 to 400 micrograms per liter (μg/L) with no specified accuracy.

Water-Quality Samples

Water samples were collected by the project partners at all sites (table 2) beginning in July 2006 and ending when the continuous monitors were removed. Samples were depth integrated to a depth that was twice the secchi depth by using a single-bottle weighted sampler. Barometric pressure and secchi depth were measured and recorded during sample collection. Water temperature, specific conductance, dissolved oxygen, pH, and turbidity were measured and recorded at the secchi depth using a calibrated water-quality monitor at the time of the sample collection. The samples were chilled, filtered when necessary, processed, and shipped to The University of North Carolina at Chapel Hill Institute of Marine Sciences analytical laboratory for analysis. The samples were collected and processed using techniques described in the USGS national field manual for the collection of water-quality samples (U.S. Geological Survey, continually updated).

Water-quality samples were analyzed for total suspended solids, total carbon, dissolved organic carbon, dissolved silica, chlorophyll *a*, total particulate nitrogen, total dissolved nitrogen, dissolved nitrite plus nitrate, dissolved ammonia, and dissolved orthophosphate. The IMS laboratory methods used for each analysis are listed in table 3. All sample results were reported to the USGS and stored in the NWIS database.

Quality Assurance and Data Archival

Water elevation, velocity, and discharge data were collected and quality assured by the USGS using methods described in Rantz and others (1982), Rantz (1982), and Ruhl and Simpson (2005). To ensure a uniform water-quality dataset, the USGS trained the ECSU, NERR, and FWS project partners in data collection and documentation techniques for the collection of continuous water-quality data and water-quality sampling in accordance with methods described in Wagner and others (2006), as modified for this study, and the U.S. Geological Survey (continually updated). The USGS project personnel periodically accompanied project partners to the data-collection sites to provide additional training and assistance and to collect quality-assurance samples.

The USGS collected one to three duplicate water-quality samples at each site for analysis at the USGS National Water Quality Laboratory (NWQL) for comparison with results of the water-quality analyses conducted at the IMS laboratory. In

Table 3. Analytical methods used to analyze the water-quality samples collected in and around Currituck Sound in North Carolina and Virginia, 2006–2007.

[IMS, The University of North Carolina at Chapel Hill Institute of Marine Sciences; NWQL, U.S. Geological Survey National Water Quality Laboratory; SM, standard methods; USGS, U.S. Geological Survey; EPA, U.S Environmental Protection Agency]

Analyte	IMS analytical method and citation	NWQL analytical method and citation
total suspended solids	SM 2540 D, Eaton and others (2005)	USGS I-3765-89, Fishman and Friedman (1989)
total carbon	EPA 440.0, U.S. Environmental Protection Agency (1997)	EPA 440.0, U.S. Environmental Protection Agency (1997)
dissolved organic carbon	EPA 415.3, U.S. Environmental Protection Agency (2005)	USGS O-1120-92, Brenton and Arnett (1993)
dissolved silica	SM 4500-SiO2 F, Eaton and others (2005)	USGS I-2700-89, Fishman and Friedman (1989)
chlorophyll *a*	EPA 445.0, Arar and Collins (1997)	EPA 445.0, Arar and Collins (1997)
total particulate nitrogen	EPA 440.0, U.S. Environmental Protection Agency (1997)	EPA 440.0, U.S. Environmental Protection Agency (1997)
total dissolved nitrogen	calculated (no citation)	calculated (no citation)
dissolved nitrite + nitrate	SM 4500-NO3 I, Eaton and others (2005)	USGS I-2546-91, Fishman (1993)
dissolved ammonia	SM 4500-NH3 H, Eaton and others (2005)	USGS I-2525-89, USGS I-2522-90, Fishman (1993)
dissolved orthophosphate	SM 4500-P G, Eaton and others (2005)	USGS I-2601-90 , USGS I-2606-89, Fishman (1993)

addition, equipment blanks were collected by the USGS and project partners and analyzed at the IMS laboratory and the NWQL for quality assurance.

All data were processed by USGS personnel and published in the USGS annual water-resources data report for North Carolina (U.S. Geological Survey, 2007, 2008). Water elevation, velocity, discharge, and water-quality data collected by the USGS and the project partners during this study are stored in the USGS NWIS database. The continuous data available for each site and the number of complete days in the continuous record are presented in figure 2 and table 4. All project data can be obtained through the NWIS web interface at *http://waterdata.usgs.gov/nc/nwis* or in the USGS annual water-resources data report (U.S. Geological Survey, 2007, 2008).

Summary

Because of changes in ecological conditions in and around Currituck Sound in northeastern North Carolina and southeastern Virginia, a team of scientists from multiple project partners was assembled to conduct an investigation of the hydrologic and water-quality characteristics of the sound and its major tributaries. As part of this investigation, a comprehensive set of hydrologic and water-quality data were collected in and around Currituck Sound during January 2006–September 2007. The data-collection network was designed to provide information needed to develop and apply a hydrodynamic and water-quality model to Currituck Sound to evaluate the effects of various management scenarios. The data were collected at nine sites and include continuous discharge, water elevation and velocity, and physical measures of water-quality conditions; discrete water samples were collected for analysis. The project partners who participated in the data collection included Elizabeth City State University, North Carolina National Estuarine Research Reserve, and U.S. Fish and Wildlife Service, which were responsible for water-quality data collection; The University of North Carolina at Chapel Hill Institute of Marine Sciences (IMS), which provided laboratory analyses of water-quality samples; and the U.S. Geological Survey, which was responsible for hydrologic data collection, water-quality data-collection oversight and quality assurance, and data processing. The U.S. Geological Survey provided training and quality assurance for the data-collection activities, processed the data, and archived all data in the USGS NWIS database.

Acknowledgments

The USGS would like to thank John Morris, John Sutherland, and Darren England of the North Carolina Division of Water Resources; Mitch Hall and John Hazelton of the U.S. Army Corps of Engineers; Amber Eure, Elizabeth Noble, and Kathleen Fisher of Elizabeth City State University; John Fear, Ann Wunderly, and Susan Dworsky of the North Carolina National Estuarine Research Reserve; John Gallegos, Sterling Valentine, and Sharon Tatem of the U.S. Fish and Wildlife Service; and Hans Paerl, Ben Perlis, and Karen Rossingol of the University of North Carolina at Chapel Hill Institute of Marine Sciences for the unique cooperation that occurred during this project. Also, appreciation is extended to the private property owners and the U.S. Army Corps of Engineers for allowing access to their property during this data-collection effort.

Table 4. Number of complete days of continuous record data collected in and around Currituck Sound in North Carolina and Virginia from January 2006 through September 2007.

[—, data not collected]

Site number (fig. 1)	Water elevation	Water velocity	Stream discharge	Water temperature	Specific conductance	Salinity[a]	Dissolved oxygen	pH	Turbidity	Chlorophyll *a*
4	553	557	558	428	428	428	425	428	413	405
5	558	558	558	482	482	482	445	419	373	410
6	617	615	616	487	487	487	385	487	425	429
7	560	560	560	—	—	—	—	—	—	—
14/15	—	—	—	401	401	401	365	368	377	342
20	608	610	611	443	443	443	431	426	307	443
21	—	—	—	414	414	414	385	410	323	—
23	—	—	—	450	450	450	431	450	411	—
24	559	559	—	505	504	504	479	496	468	—

[a]Calculated from specific conductance data (Miller and others, 1988).

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