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Regional Sediment Management Strategies for the Vicinity of St. Augustine Inlet, St. Johns County, Florida

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July 2016



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Regional Sediment Management Strategies for the Vicinity of St. Augustine Inlet, St. Johns County, Florida

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Abstract

This report provides a description of Regional Sediment Management (RSM) investigations performed by the U.S. Army Corps of Engineers (USACE), Jacksonville District (SAJ), in the vicinity of St. Augustine Inlet, St. Johns County, FL. Objectives of this study include beneficially using dredged material, coordinating dredging schedules for navigation and storm damage reduction projects, maintaining channels, investigating alternatives to better stabilize beaches, and coordinating improvements to the state's inlet management plan for St. Augustine Inlet. Four RSM strategies developed here are applicable to other regions with multiple projects and sediment-related needs.

Strategy 1 (Multiple Sand Sources): Especially beneficial to navigation when the channel can be dredged first.

Strategy 2 (Nearshore Placement vs. Beach Placement): Hopper dredge can dump in nearshore or use beach pump-out capabilities (if available). Pipeline dredge can dredge from all permitted sources with direct beach placement.

Strategy 3 (Hopper Dredge): Dredge main channel, then access ebb shoals, then obtain remaining sand requirements from offshore sources. Benefits navigation by clearing channel and shoal first.

Strategy 4 (Alternate Sources): May be advantageous to alternate sources to minimize mobilization/demobilization and maximize use of sand impacting navigation channel. Scheduling depends on dredging needs of the channel and nourishment needs of the beaches.

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Preface

This study was conducted for Headquarters, U.S. Army Corps of Engineers (HQUSACE), Washington, D.C. under the USACE Regional Sediment Management (RSM) Program; Project 454632, “St. Augustine Inlet RSM” Project. The USACE RSM Program Manager was Linda S. Lillycrop, CEERD-HN-C. Jeffrey A. McKee was the HQUSACE Navigation Business Line Manager overseeing the RSM Program.

The work was performed by the U.S. Army Engineer District, Jacksonville (SAJ), and by the Coastal Engineering Branch (CEERD-HN-C) of the Navigation Division (CEERD-HN), U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (ERDC-CHL). At the time of publication, Tanya M. Beck was Chief, CEERD-HN-C, and Jackie S. Pettway was Chief, CEERD-HN. W. Jeff Lillycrop (CEERD-CHL) was the ERDC Technical Director for Civil Works and Navigation Research, Development, and Technology Transfer (RD&T) portfolio. The Director of ERDC-CHL was José E. Sánchez.

The Commander of ERDC was COL Bryan S. Green, and the Director was Dr. Jeffery P. Holland.

Unit Conversion Factors

Multiply	By	To Obtain
cubic yards	0.7645549	cubic meters
cubic yards per foot	2.50838	cubic meters per meter
cubic yards per year	0.76456	cubic meters per year
cubic yards per 5 years	0.76456	cubic meters per 5 years
feet	0.3048	meters
miles	1.60934	kilometers

1 Introduction

This technical report provides a description of the Regional Sediment Management (RSM) investigations performed by the U.S. Army Corps of Engineers (USACE), Jacksonville District (SAJ), in the vicinity of St. Augustine Inlet, St. Johns County, FL.

Background

RSM is a systems-based approach that integrates the management of littoral, estuarine, and riverine sediments to achieve balanced and sustainable solutions to sediment-related needs in a region (Lillicrop et al. 2011). RSM goals in the vicinity of St. Augustine Inlet include beneficially using dredged material, coordinating dredging schedules for navigation and storm damage reduction projects, maintaining navigation channels, investigating alternatives to better stabilize beaches, and coordinating improvements to the State of Florida's inlet management plan for St. Augustine Inlet.

These goals can be reached by coordinating available funds, permits, and Federal authorities. This document describes the RSM coordination for Federal projects within the St. Augustine Inlet vicinity and resulting benefits. The RSM strategies developed here are applicable to other regional systems with multiple projects and sediment-related needs.

As a result of stakeholder coordination in 2000 that focused on implementing RSM in northeast Florida, the Federal St. Johns County Shore Protection Project (SPP) used the St. Augustine Inlet ebb shoal as a sand source for the initial nourishment (2001 through 2003) of the St. Augustine Beach SPP and for an emergency renourishment after the damaging 2004/2005 hurricane season. After the 2005 renourishment, concern arose regarding theorized connections between dredging the ebb shoal and erosion of adjacent beaches. The concern launched efforts to identify other sand sources by investigating sediment transport in greater detail within the region and to better coordinate navigation and shore protection in the inlet vicinity. To coordinate projects, the sediment pathways, sources, and sinks within the beach and inlet system were investigated. The existing sediment budget was updated to reflect construction of the St. Augustine Beach SPP and dredging of St. Augustine Inlet.

These efforts resulted in the 2012 renourishment of the St. Augustine Beach SPP using an integrated dredging approach, to the satisfaction of all stakeholders. The approach used three sediment sources in close proximity: (1) a land-connected shoal on the north side of the inlet throat, (2) the inlet channel, and (3) the ebb shoal. Ultimately, this provided for completion of the beach renourishment, removed shoals, allowed advanced maintenance of the navigation channel, and helped alleviate concerns from stakeholders regarding use of the ebb shoal. This translated into approximately \$13,000,000 in savings to the Federal navigation program, according to SAJ records.

The phrase “St. Johns County SPP” is all encompassing and pertains to several coastline segments of St. Johns County, FL. At the present time, St. Augustine Beach SPP, located to the south of St. Augustine Inlet, is the only segment of the St. Johns County SPP that has been nourished. Hence, for this document, the phrases “St. Johns County SPP” and “St. Augustine Beach SPP” may be used interchangeably. SAJ is presently conducting a feasibility study of potential additional segments of the overall St. Johns County SPP for nourishment, including South Ponte Vedra Beach and Vilano Beach, both located to the north of St. Augustine Inlet.

Objectives

The objectives of this study are to (1) better implement RSM in the vicinity of St. Augustine Inlet, St. Johns County, FL, and (2) improve the performance of Federal navigation and storm damage reduction projects located within the project area by using qualitative information and modeling to develop management strategies in keeping with state, local sponsor, and Federal objectives.

To meet these objectives, the following questions were investigated and evaluated:

1. Is there enough sand to supply the shore protection needs in the system?
2. How can the navigation projects, and current and potential shore protection projects, optimize the use of funding, time, and equipment?
3. Can the navigation dredging and shore protection renourishment intervals coincide?

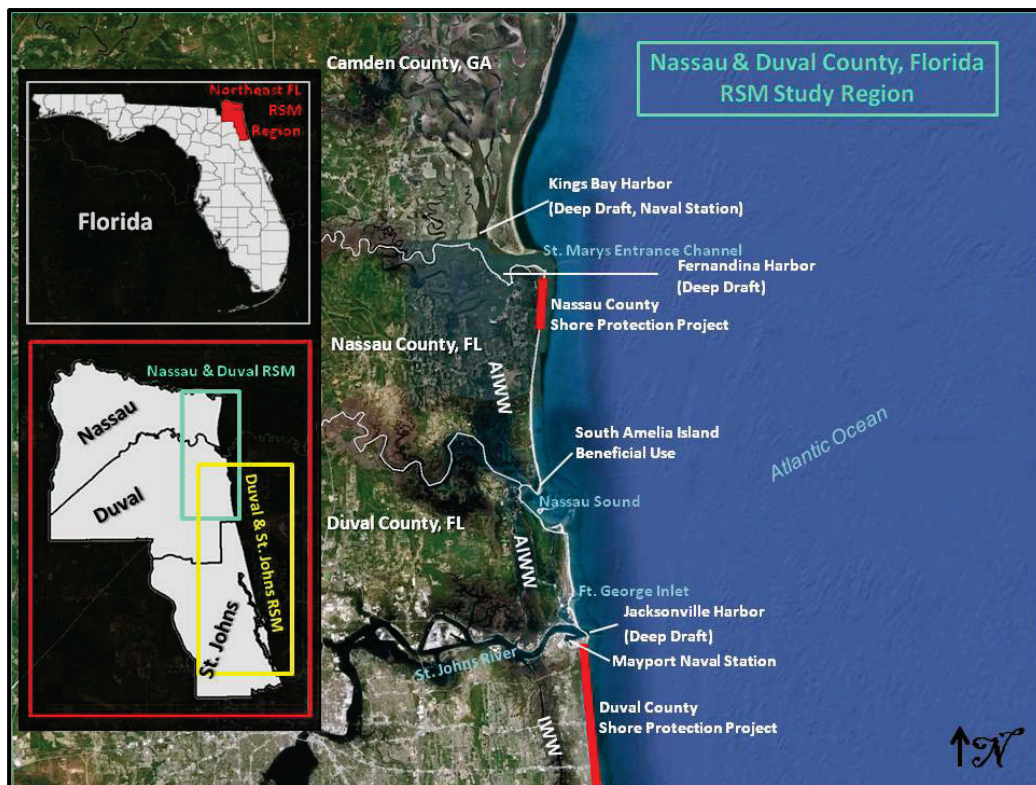
Approach

The study approach was to evaluate six strategies for implementing RSM in the St. Augustine Inlet vicinity that may be mutually beneficial to SAJ and the Florida Department of Environmental Protection (FDEP).

Early in the national RSM program development, SAJ identified the northeast Florida region encompassing Nassau and Duval Counties, and the study area of this report (St. Johns County) as an ideal location to implement RSM due to the number of navigation and coastal storm damage reduction projects, as well as parklands (natural systems) within the region.

Implementation strategies and recommendations for Nassau and Duval Counties (Figure 1) immediately to the north of St. Johns County are described in Hodgens et al. (2016). The document *Regional Sediment Management: Background and Overview of Initial Implementation* (Martin 2002) details SAJ's efforts. Several workshops organized by SAJ in 2000, and conducted with the State of Florida and other stakeholders, identified potential RSM strategies for the region.

Figure 1. Northeast Florida RSM study areas in Nassau and Duval Counties, immediately north of St. Johns County, FL. (after Hodgens et al. 2016).



These strategies are reflected in the FDEP *Strategic Beach Management Plan for the Northeast Atlantic Coast Region* (FDEP 2008) and *St. Augustine Inlet Management Implementation Plan* (FDEP 2014). It is SAJ's goal to coordinate with the FDEP and implement strategies mutually beneficial to both the USACE and FDEP missions by leveraging Federal authorities, permits, and funding. The following describes the FDEP strategies for northeast Florida and their developments to date, through collaboration with SAJ.

- **Stabilizing the south end of Amelia Island using sand from the Atlantic Intracoastal Waterway (AIWW).** The south end of Amelia Island, Nassau County, was stabilized with the beneficial use of beach quality material from the Operation and Maintenance (O&M) dredging at Sawpit Creek (a cut of the AIWW); local renourishment efforts using an offshore sand source; and construction of a terminal groin at the south end of Amelia Island.
- **Bypassing sand at the St. Marys River entrance intercepted north of the jetty at Cumberland Island and placement of dredged material on a shore protection project.** Currently it is believed that removing material at the south end of Cumberland Island where material is accreting would be too difficult since the island is a National Seashore and would require consent from the National Park Service. However, this strategy requires additional investigation. Bypassing is indirectly achieved by dredging the St Marys River entrance channel and placing beach quality material on the beach south of the inlet. Dredged material is placed within the limits of the Federal Nassau County SPP that was initially constructed in 2008, implementing the last portion of the strategy.
- **Backpassing sand at Ft. George Inlet and bypassing sand at the St. Johns River entrance from north of the jetty to the Duval County SPP.** SAJ's RSM strategy for Nassau and Duval counties is currently investigating the feasibility of using Ft. George Inlet as a sediment source for the Duval County SPP. Backpassing sand could be evaluated. However, the Corps does not have permits to place sand for beach nourishment north of Ft. George Inlet except within the limits of the Nassau County SPP, approximately 16 miles to the north.
- **Offloading beach quality material onto shoreline areas. Since 2000, the upland disposal area, SJ-1, in St. Johns County, has been offloaded multiple times onto the beach of nearby Summer Haven.** Other offloading opportunities exist at upland

- disposal site Dredged Material Management Areas (DMMA) in Duval County (Buck Island) and Nassau County DMMA DU-2. However, logistics and permitting are consistently problematic. Neither DMMA is owned by the Corps, so SAJ has no authority to direct how beach quality material is offloaded or used. As of January 2014, beach quality material from both DMMA's was offloaded for upland construction projects. Material from Buck Island went to a highway construction project, and material from DU-2 was used to construct a new DMMA.
- **Demonstrating innovative technologies to maximize placement of beach quality material in the littoral zone.** The innovative use of coastal sediment transport models (discussed later in this report) represents significant advances in understanding sediment dynamics. The methods employed in St. Johns County have been duplicated elsewhere in Florida and allowed SAJ to effectively respond to agency queries and receive permits that maximize placement of beach quality material. The State of Florida has recently funded Florida State University to revise most state inlet management plans by using this method.
 - **Bypassing sand at St. Augustine Inlet, linking navigation and shore protection efforts.** (This document describes the investigations that led to implementing and achieving this strategy at St. Augustine Inlet, St. Johns County, FL.)

2 Study Area Projects and Features

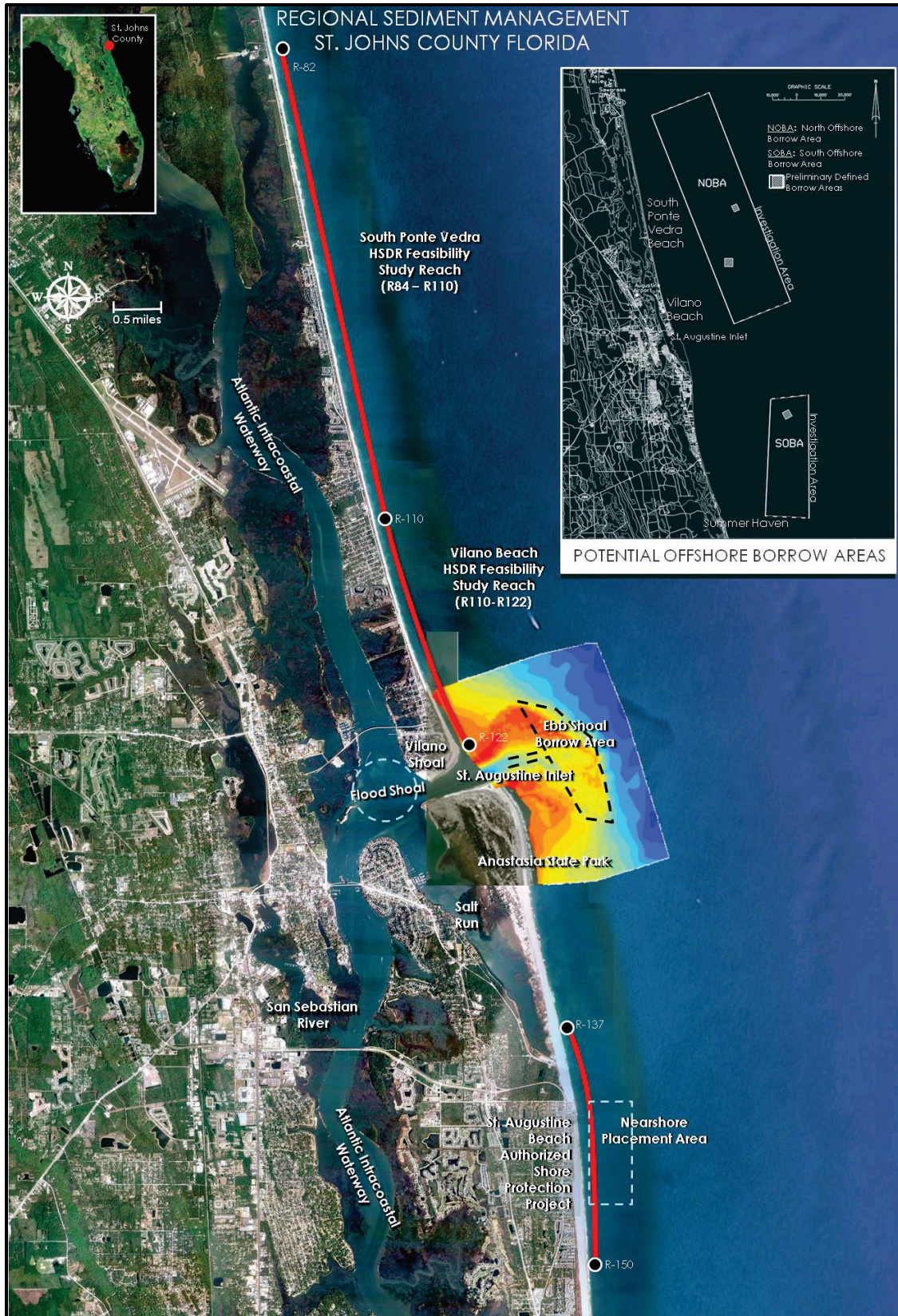
St. Augustine Inlet and St. Augustine Harbor

St. Augustine Inlet is an improved tidal inlet in St. Johns County on the northeast Atlantic coast of Florida, connecting the Tolomato and Matanzas Rivers to the Atlantic Ocean (Figure 1). The county is bounded on the north by Duval County, on the south by Flagler County, and contains approximately 42 miles of Atlantic coastal shoreline along three barrier islands. The St. Johns County RSM study area begins at the State of Florida survey range (R) monument R-82, which is the northern limit of influence of St. Augustine Inlet. The study area continues south along the coast including the Intracoastal Waterway (IWW), St. Augustine Inlet, Anastasia State Park, and ends at monument R-150. This is the southernmost extent of the St. Augustine Beach reach of the authorized Federal St. Johns County SPP. Range monuments are maintained by the FDEP and are spaced approximately 1,000 feet (ft) apart along the county's shoreline. R-monument numbering begins with R-1 at the northern county border.

The study area includes three Federal navigation projects: (1) the St. Augustine Inlet, (2) the IWW, and (3) the San Sebastian River. There is at present one authorized SPP to the south of St. Augustine Inlet (St. Augustine Beach SPP) and a current Federal feasibility study for Hurricane and Storm Damage Reduction (HSDR) north of the inlet. It is the proximity of these projects, and their reliance on the dredging and placement of sediment, that makes this an ideal area for RSM implementation. There is at present no authorized SPP to the north of St. Augustine Inlet.

The inlet channel was relocated in 1940 as part of the Federal St. Augustine Harbor Navigation Project in response to public interests. Salt Run (Figure 2) is the remnant of the original natural inlet that was located approximately 2.5 miles south of the inlet's current location. Efforts to stabilize the inlet and improve navigation during the period 1941 to 1957 resulted in the construction of a north sand-trap groin structure approximately 1,880 ft in length and a 3,695 ft long southern jetty structure. The inlet channel and associated structures are maintained by SAJ. The project includes an outer channel authorized to -16 ft mean lower low water (mllw) plus 2 ft of allowable over-depth, and a 12 ft deep inner channel connecting

Figure 2. St. Augustine Inlet and vicinity, FL, and RSM study area.



to the IWW. The channel can be dredged to achieve an alignment of *best fit* within the confines of a 600 ft wide easement between the south jetty and the north shore.

Between 1940 and 1986, dredged material from the navigation channel was typically disposed offshore. A 1996 dredging event resulted in the placement of suitable material on the down-drift beaches located south of the inlet (FDEP 1998). In 1999, periodic maintenance dredging of the inlet was initiated with beach placement of dredged material at Anastasia State Park and St. Augustine Beach (FDEP 2008).

St. Augustine Harbor and a portion of the adjacent beach at Anastasia State Park have been designated as part of the Coastal Barrier Resources System by the U.S. Department of the Interior.

Authorization and funding

Between 1888 and 1894, Congress appropriated funds for improving St. Augustine Harbor by constructing seven groins, four along Anastasia Island and three on North Point. In 1902, the project was recommended for abandonment, but no formal action was taken by Congress. There is no explanation for abandonment in the District records, nor is there any description of what happened to the groins. It is likely they, or what was left of them, remained on the beach until buried or eroded away. The existing project for St. Augustine Harbor was adopted by the River and Harbor Act of 20 June 1938 (USACE 1947).

Shallow draft inlets such as St. Augustine that mainly support recreational craft currently do not often receive Federal funds for dredging maintenance. However, during the 2012 renourishment event, shoaled portions of the entrance channel were dredged under authority and with funding from the St. Johns County SPP project. The channel was deemed to be a borrow source for the renourishment project. This innovative solution allowed material from the channel to be dredged and returned to the littoral system. It also allowed the channel to be dredged beyond its authorized navigation depth since dredging was accomplished for a purpose other than just navigation. For navigation projects, authorized depths are determined based on cost effectiveness, not only on hydraulic considerations. A channel that does not support deep-draft commercial vessels will not usually be authorized to be dredged to additional depth for advanced maintenance. O&M funds are typically used to maintain navigation inlets.

Permitting

St. Augustine Harbor is covered under a 10-year permit with a construction phase expiration date of 8 December 2020 (Permit Number: File No. 0251706-001-JC). This permit covers various dredging and placement sites in the study area, representing an RSM-oriented permit. Note the value provided by having various dredging projects and placement opportunities under one permit to facilitate RSM activities.

St. Johns County Shore Protection Project (SPP) (St. Augustine Beach SPP)

The authorized St. Augustine Beach SPP consists of 2.5 miles of beach nourishment (R-137 to R-150, plus north and south tapers), a 60 ft wide berm at 12 ft elevation above mean low water (mlw), and an initial construction and periodic renourishment for 50 years. Tapers of 600 ft on the north and south ends are included in the design. The 1999 authorization includes cost-sharing information, where 50% of the total project costs will be considered mitigation for impacts to the shoreline from navigational improvements at St. Augustine Inlet. The remaining 50% of total project costs are cost-shared according to shoreline ownership, use, and public access. The 1998 General Re-evaluation Report calculated the Federal participation percentage to be 80.5% (including mitigation for navigation impacts).

The project was initially constructed between 2001 and 2003 with approximately 3.8 million cubic yards (Myd³) of sand dredged from the St. Augustine Inlet ebb shoal. At the same time, an additional 400,000 yd³ of sand were dredged from the ebb shoal at the request of FDEP for placement in Anastasia State Park. The project has a 5-year renourishment interval; however, emergency renourishment was required in 2005 due to the severe 2004 hurricane season. The most recent renourishment was completed in November 2012.

Authorization and funding

The Rivers and Harbors Act of 1962 gave the Secretary of the Army broad authorization to survey coastal areas of the United States and its possessions in the interest of beach erosion control, hurricane protection, and related purposes, provided those surveys of particular areas would be authorized by appropriate resolutions (Public Law 87-874, Section 110). As

a result, portions of the St. Johns County shoreline experiencing severe erosion were studied extensively. The latest General Re-evaluation Report was authorized by the Water Resources Development Act of 1986 (Public Law 99-662 dated 17 November 1986) as modified by Section 316 of the Water Resources Development Act of 1999 (WRDA99). Construction General (CG) funds are used for initial construction and renourishment of shore protection projects.

Permitting

Two permits pertain to the placement of material on the beach and nearshore of this Federal project. A 10-year permit with an expiration of construction phase date of 8 December 2020 covers beneficial use actions where material dredged from navigation projects can be placed on the beach or nearshore (Permit Number: File No. 0251706-001-JC).

Permit Number 0295429-002-JC covers sand dredged and placed specifically for the St. Johns County SPP. This also is a 10-year permit expiring in 2021, authorizing 2.1 Myd³ of sand to be placed on the St. Augustine Beach SPP. The permit is limited to a one-time use of the ebb shoal borrow area. Notably, the permit takes a tiered approach to dredging three separate sources: (1) the borrow areas to be dredged from within the Federally authorized navigation channels, (2) a 200 ft widener along the south side of the navigation channel, and (3) that portion of Vilano Point (also referred to as Porpoise Point) that encroaches into the navigation easement. After all available material from within those areas has been transported to the beach, then dredging can commence at the southern boundary of the borrow area in the south lobe of the ebb shoal and proceed north through any or all of the various sub-areas. Dredging cannot extend north of the navigation channel. The borrow areas are located within the St. Augustine Inlet in water depths between -5 and -30 ft North American Vertical Datum of 1988 (NAVD88). The beach nourishment site is located from 600 ft north of R-137 to 600 ft north of R-151.

Anastasia State Park

Anastasia State Park and Recreation Area is directly south of St. Augustine Inlet. The park begins at R-123 immediately south of the St. Augustine Inlet and continues until the start of St. Augustine Beach at R-141. The park is within the influence area of the inlet and has a spur groin that was

built in 1973 (FDEP 2008). Maintenance dredging material of the inlet has been periodically placed on the park beaches since 1996.

Permitting

This placement area is covered under a 10-year permit with a construction phase expiration date of 8 December 2020.

Permit Number 0251706-001-JC is the same permit covering dredging of St. Augustine Inlet and is also one of the permits covering dredged material placement on the Federal shore protection project at St. Augustine Beach. The shoreline of the park covered by the permit extends from R-137 to R-141. Suitable material can be filled to a berm elevation of 10 ft NGVD88, with a variable berm width of 100 to 200 ft and a seaward slope of 1:20 (vertical:horizontal). If suitable coquina shell hash is dredged, that material may be placed above the wrack line (high tide line) in Anastasia State Park to enhance shore bird nesting habitat. Some of the beach-compatible sand may also be used to enhance the dunes within Anastasia State Park. The dunes will have a crest elevation of 17 ft NAVD88 and side slopes of 1:5 (vertical:horizontal).

A one-time modification to the permit was obtained in FY13 to place 250,000 yd³ of material on the beach from R-127 to R-131. The material came from a supplemental O&M dredging of the inlet.

Subsection 62B-41.005(15), Florida Administrative Code (Florida State sand rule), directs that sand dredged specifically for the purpose of beach nourishment cannot have greater than 5% fines passing the 230-size sieve. However, sandy sediment derived from the maintenance of coastal navigation channels shall be deemed suitable for beach placement with up to 10% fine material passing the 230-size sieve.

St. Johns County HSDR Feasibility Study: South Ponte Vedra Beach, Vilano Beach, and Summer Haven

The purpose of the current St. Johns County HSDR Feasibility Study is to determine the feasibility of formulating a recommended plan for storm damage reduction, including opportunities for environmental restoration, within the South Ponte Vedra Beach, Vilano Beach, and Summer Haven reaches of the St. Johns County coastline. The South Ponte Vedra Beach and Vilano Beach reaches are located within the RSM study area

(Figure 2). Summer Haven is located at the southern end of the St. Johns County coastline and is not within the study area, although past RSM activities have been carried out in Summer Haven.

The South Ponte Vedra Beach reach, located between monuments R-84 and R-110, is a 5-mile stretch that begins approximately 7.5 miles north of the St Augustine Inlet. This reach has experienced accelerated erosion within the past 10 years and was designated *critically eroding* in 2007 by FDEP. Critically eroded beaches are candidates for state funding through FDEP for coastal storm damage reduction. FDEP is a cost-sharing partner with the local sponsor, St. Johns County, for the feasibility study.

The Vilano Beach reach is located between R-110 and the north jetty of St. Augustine Inlet (approximately R-122). The total shoreline distance for this reach is 2.5 miles. The FDEP designated R-109 through R-117 (1.6 miles) as a critically eroded area in 2006 when rapid erosion began to threaten private development and State Highway A1A. Due to this erosion, several homes had to be temporarily vacated for major repairs, and several structures were granted permits to construct temporary sea walls around a hotspot (an area of rapid and chronic erosion) in the vicinity of R-114. Just south of this hotspot, the dune was eroded to within 5 ft of A1A after the passage of Tropical Storm Fay in 2008. A portion of this reach is armored with shore protection structures while the remainder has a fairly narrow beach and a 10 to 15 ft high natural dune.

The shoreline from R-117 to the north jetty of St. Augustine Inlet (approximately R-122) has not experienced accelerated erosion like that of the area between R-110 and R-117, possibly due to its proximity to the north jetty of St. Augustine Inlet that inhibits the southward transport of sand.

Authorization and funding

This project was authorized by the WRDA of 1986 (Public Law 99-662 dated 17 November 1986) as modified by Section 316 of WRDA99. Specific to this study, on 21 June 2000, House Resolution 2646 granted authority for a survey of the St. Johns County study area. That resolution authorized a reconnaissance study that was completed in 2004 and concluded that there was a Federal interest in conducting a feasibility study.

General Investigation (GI) funds are used for this study. Offshore borrow areas (Figure 2) are being investigated as sand sources for any potential recommended project requiring sand placement.

Permitting

This project is in the feasibility stage and currently has no associated permits.

The Intracoastal Waterway (IWW)

The IWW, extending from Jacksonville to Miami, is part of the AIWW system that provides an inland navigation channel from New York to Miami. Dredging of the IWW in the study area is authorized at -12 ft mllw plus 2 ft of allowable over-depth to a total project depth of -14 ft mllw, with a bottom width of 125 ft and 1:3 (vertical:horizontal) side slopes. The flood shoal adjacent to the IWW Channel may also be dredged to the same depth as the channel.

In St. Johns County, the IWW crosses through the Tolomato River, continues south to St. Augustine Inlet, and then continues west through the estuarine embayment formed by the convergence of the Tolomato and Matanzas Rivers. From there it continues south through the Matanzas River and Matanzas Inlet.

Taylor and McFetridge (1989) provide a discussion on material quantities and locations within the IWW in St. Johns County and concluded that historical dredging and/or recent shoaling within the county study area has been primarily concentrated in two distinct reaches of the waterway. The greater portion has occurred adjacent to Matanzas Inlet, south of the RSM study area. Shoaling within this reach has historically represented 78% of the total for the entire county. An area farther to the north in the vicinity of Palm Valley (south of the RSM study area) has accounted for an additional 20% of the total quantity within the county. The central 18.8 miles, which encompass IWW Reaches III and IV including the vicinity of the St. Augustine Inlet, have required Federal dredging for channel construction and/or maintenance. Sections of the IWW within the RSM study area are periodically dredged.

Beach quality material is placed on Anastasia State Park, with the possibility of placement on St. Augustine Beach. Dredging activity can place sediments

unsuitable for the beach in the nearshore placement area. This placement area is located adjacent to the beach placement area (approximately between R-146 to R-141) and extends from mllw to the -20 ft mllw contour line with a maximum top elevation not to exceed -12 ft mllw.

Authorization and funding

The current dimensions of the IWW were authorized by the River and Harbor Act approved 2 March 1945. O&M funds are typically used for channel maintenance. The non-Federal sponsor, the Florida Inland Navigation District (FIND), cost shares in funding. Since 2012, the non-Federal sponsor has paid 100% of the maintenance costs.

Permitting

Permit Number 0251706-001-JC pertains to dredging the IWW. This project is covered under a 10-year permit with an expiration of construction phase date of 8 December 2020.

San Sebastian River

The San Sebastian River channel, a Federal project, extends 13,650 ft from the U.S. Highway 1 Bridge south to the river's confluence with the Matanzas River (Figure 2). The channel was recommended for dredging in the 1947 Survey-Review Report on St. Augustine Harbor and Vicinity, Florida (USACE 1947). With an authorized width of 100 ft and an authorized depth of -10 ft mlw, the river provides recreational boats, shrimp boats, and other commercial vessels access to the IWW and the Atlantic Ocean via St. Augustine Inlet. No dredging has occurred in the San Sebastian River since the original channel deepening in 1956. That operation removed 100,000 yd³ of material from the river. A USACE survey of the river in 1991 identified several shoals totaling 14,625 yd³ of material that severely limit the controlling channel depth to -4.3 ft mlw. No recent bathymetric surveys or maintenance activities have taken place; thus, parts of the river remain shoaled at less than project depth (Taylor Engineering, Inc. 2005).

Authorization and funding

The San Sebastian River portion of the St. Augustine Harbor project was authorized by the River and Harbor Act of 17 May 1950 (Public Law 516, 81st Congress, 2nd Session) as set forth in House Document No. 133, 81st Congress 1st Session, "St. Augustine Harbor and Vicinity, Florida."

Authority to proceed with the San Sebastian River as a separate and distinct feature of the authorized project was contained in first endorsement dated 17 August 1955 by the Division Engineer to letter dated 12 August 1955, subject “Unbudgeted New Start, Project F. Y. 1956, St. Augustine Harbor, Florida.”

Permitting

No permit currently exists for the San Sebastian River.

Vilano Shoal (also known as Vilano Point and Porpoise Point)

Vilano Shoal is alternately called Vilano Point or Porpoise Point in various documents. It is the point of land above and below the waterline that has accreted south of the St. Augustine Inlet’s north sand-trap groin. The 1947 Corps survey report of the inlet vicinity describes rapid shoaling of the inlet taking place immediately after construction was initiated in 1940. The report describes sand accreting in the channel south of the original 1,880 ft long stone and creosoted timber sand-trap groin. This area is Vilano Shoal, which continues to accrete sand, representing a potential sand source but hazard to navigation. However, dredging the shoal has potential impacts to habitat and local recreation. Upland portions of the Point are vegetated and provide nesting bird habitat. Beach driving is permitted in this area, and many visitors and residents access the Point for recreation such as fishing. Any dredging must take impacts to these resources into consideration, as well as the proximity of homes and infrastructure just north of the Point.

Authorization and funding

Authority to dredge the Vilano shoal and the Point would typically fall under the authority for the St. Augustine Inlet once the shoal begins to encroach on the 600 ft wide navigation channel. The shoal and Point have accreted south of the sand trap groin and partly within the footprint of the inlet entrance channel. However, during the 2012 renourishment event, the Point was dredged under the St. Johns County SPP project since the Point was viewed as a borrow source for the renourishment project. This innovative solution allowed material outside of the channel footprint to be dredged and returned to the littoral system.

Work to dredge the shoal would have typically been funded by O&M. However, the 2012 dredging was funded through CG funds from the St. Johns County SPP. The dredged material was used in conjunction with other sources to nourish the Federal project.

Permitting

This project is covered under a 10-year permit with an expiration of construction phase date of 8 December 2020. Permit Number: File No. 0251706-001-JC pertains to this project. This permit covers various dredging and placement sites in the study area, representing an RSM-oriented permit. Note the value provided by having various dredging projects and placement opportunities under one permit to facilitate RSM activities. More detailed information is provided in the RSM Issues section of this report, as well as in the St. Augustine Inlet and St. Augustine Harbor part of this section of this report.

Shell hash berm placement site

Some material dredged from the Vilano Shoal is excessively shelly (shell hash) and not beach compatible. A placement site has been permitted at a dune breach around R-131 for this material as a *bird berm* 6 to 9 inches deep (to provide a substrate for nesting shorebirds). Placement here reduces cost and has environmental benefits.

Authorization and funding

No specific authorization is required for this placement area. Typically, O&M jobs will pay to have material placed here.

Permitting

Permit Number 0251706-001-JC is applicable to this project. This placement area is covered under a 10-year permit with an expiration of construction phase date of 8 December 2020.

Nearshore placement site

Sediments that are unsuitable for beach placement, but meeting requirements for nearshore placement (up to 20% silt [fines] content), will be placed at the nearshore placement area located adjacent to the beach placement area. The nearshore placement site is located landward of the

-20 ft mllw contour line and will be filled to a maximum elevation of -12 ft mllw. The nearshore placement site extends from FDEP monuments R-142 to R-148. It encompasses 2.7 square miles. The area has a sandy bottom with 10 to 20 ft of sand covering a rock substrate. No features such as hard bottoms or rock outcrops are located in this area.

Authorization and funding

No specific authorization is required for this placement area. Typically, the project requiring dredging would also pay to place the dredged material in this area. However, situations could arise when dredging is funded by a navigation project using O&M funds and the St. Johns County SPP or another funding source pays for the nearshore placement to reap shore protection benefits.

Permitting

Permit Number 0251706-001-JC applies to this project. This placement area is covered under a 10-year permit with an expiration of construction phase date of 8 December 2020.

Salt Run

Salt Run (Figure 2) is the remnant of the original natural inlet. It is still used for local navigation and recreation. Material has been dredged from several shoals by local interests along the run. Anecdotal information suggests that the material was too fine for beach placement.

Authorization and funding

Salt Run is not a Federal project and has no Federal authorization. Dredging has been funded by local interests and FIND.

Permitting

No Federal permit currently exists for Salt Run.

Flood shoal

The flood shoal complex has several areas that may be able to provide beach or nearshore quality sand. However, geotechnical investigations will be needed to determine the sand quality and volume available. The only

portions of the shoal that have been dredged are those adjacent to cuts of the IWW, dredged for navigational purposes.

Authorization and funding

No particular Federal authorization exists for general flood shoal dredging. However, advanced maintenance covers dredging portions of the flood shoal adjacent to the IWW. Dredging of the IWW in the study area is authorized at -12 ft mlw, plus 2 ft of allowable overdepth, with a bottom width of 125 ft and 1:3 (vertical:horizontal) side slopes. The flood shoal adjacent to the IWW channel may also be dredged to the same depth as the channel.

O&M funds are typically used for IWW dredging.

Permitting

Permit Number 0251706-001-JC is a 10-year permit with an expiration of construction phase date of 8 December 2020. This permit covers various dredging and placement sites in the study area and is discussed under other study area locations in this section of this report. Specific to the flood shoal, the permit states “the shoals that will be dredged outside of the channels are located at the intersection of the AIWW and the St. Augustine Inlet Entrance Channel, between Station 11 + 17.70 and Station 13 + 40.90, and at Vilano Point.”

Offshore borrow sources

There are two offshore borrow areas in state waters under development offshore of St. Johns County, designated as North and South Offshore Borrow Areas (Figure 2, inset). Combined, they are anticipated to have an available volume of approximately 95 Myd³. A National Environmental Policy Act (NEPA) document detailing effects of dredging and placing sand from this source will be required prior to use. A permit will also be required from the FDEP.

Authorization and funding

There is currently no authorization to use these sources. Any future authorization would result from the ongoing feasibility study for St. Johns County, a post-authorization change report for the St. Johns County SPP, or another document.

Since the only purpose for dredging these sources would be for beach nourishment, it is likely that funding would be from CG funds.

Permitting

No permits currently exist for these sources.

3 RSM at St. Augustine Inlet and Vicinity

From its initiation, RSM has been an admirable concept. RSM encourages managing a region as a system holistically, to minimize adverse impacts and maximize benefits. Its value is most notable in a coastal system where infrastructure and an incredibly important natural environment are intertwined with dynamic forces, thus highlighting the need to take a holistic management approach. However, with the varied components of a coastal system come varied stakeholders with different priorities. Additionally, Corps projects come with project-specific authorities, funding, and permitting.

Bringing together stakeholders with varied priorities can be facilitated through meetings and workshops. Early, open, and frequent coordination is the key force. Face-to-face coordination can result in highly positive impacts. A goal of this active coordination is making certain that all stakeholders should feel they are better off with RSM than without RSM.

Bridging the Corps project-specific requirements with those of stakeholder concerns can be more problematic than any stakeholder difference. Examples of project requirements that can be difficult to coordinate include the following:

- Schedule – coordinating multiple project schedules can be problematic. For example, O&M dredging is often on short schedules that may not coordinate well with scheduled actions needed to beneficially use dredged material on another project.
- Funding – combining funds for multiple federal projects, or locating non-Federal funds to beneficially use material, can sometimes be difficult.
- Permitting – like any other project, permits must be in place to realize RSM goals. However, often in the case of RSM, multiple project permits must coincide, or be in place to beneficially use material when a dredging action is completed (see “Schedule” above).
- Contracting – especially when considering Federal funds for separate projects, it can be difficult to combine the funds into one contract or coordinate the funds from separate contracts.

- Authorities – Congress authorizes federal projects for specific project purposes and with specific funding needs. Although often a problem of perception, it can be problematic when an RSM action is perceived by some to be *outside* of the project authority.

Beginning the RSM strategy in the region

RSM began in the study area in the mid-1990s when beach-compatible material dredged from navigation maintenance projects was placed on beaches south of the inlet rather than being disposed offshore. This effort maintained sand in the littoral system rather than depriving eroded beaches and dune systems of needed sand in the name of convenience.

Sediment budgets

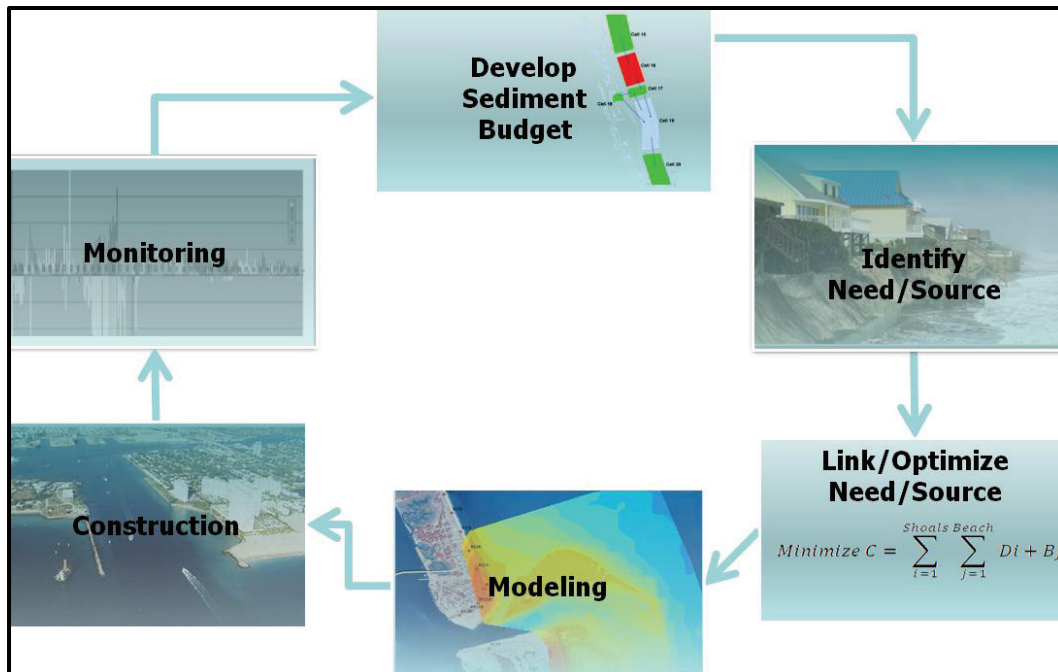
In 1997, the FDEP developed an inlet management plan based on the available sediment budget. This plan outlined objectives including periodically bypassing sand from the ebb shoal to renourish eroded down-drift beaches and improve degraded dune systems in Anastasia State Park. Using a dredge, this mechanical bypassing would mimic a natural inlet bypassing process.

As the St. Johns County Federal SPP was being formulated, the FDEP inlet management plan recommendations were included in the SPP. The SPP focused on the ebb shoal as its main borrow area, with navigation projects identified as additional sources. The proximity of this sand source and the volume of material available helped to economically justify the Federal SPP.

After the initial nourishment that ended in 2003, and after the emergency renourishment conducted in 2005, monitoring indicated that the sediment budget required additional analysis. Prior to the next renourishment, a sediment budget update was initiated to evaluate other potential sand sources and to address stakeholder concerns over the ebb shoal dredging. Based on the project's 5-year renourishment interval, the project was scheduled to be renourished in 2010, and a revised sand source plan was desired.

RSM strategies tend to be iterative due to the dynamic nature of the coastal system and the availability of new information. Both the original and 2010 strategies for St. Augustine Inlet followed this methodology, shown in Figure 3.

Figure 3. Iterative RSM strategy development for St. Augustine Inlet and vicinity, FL.

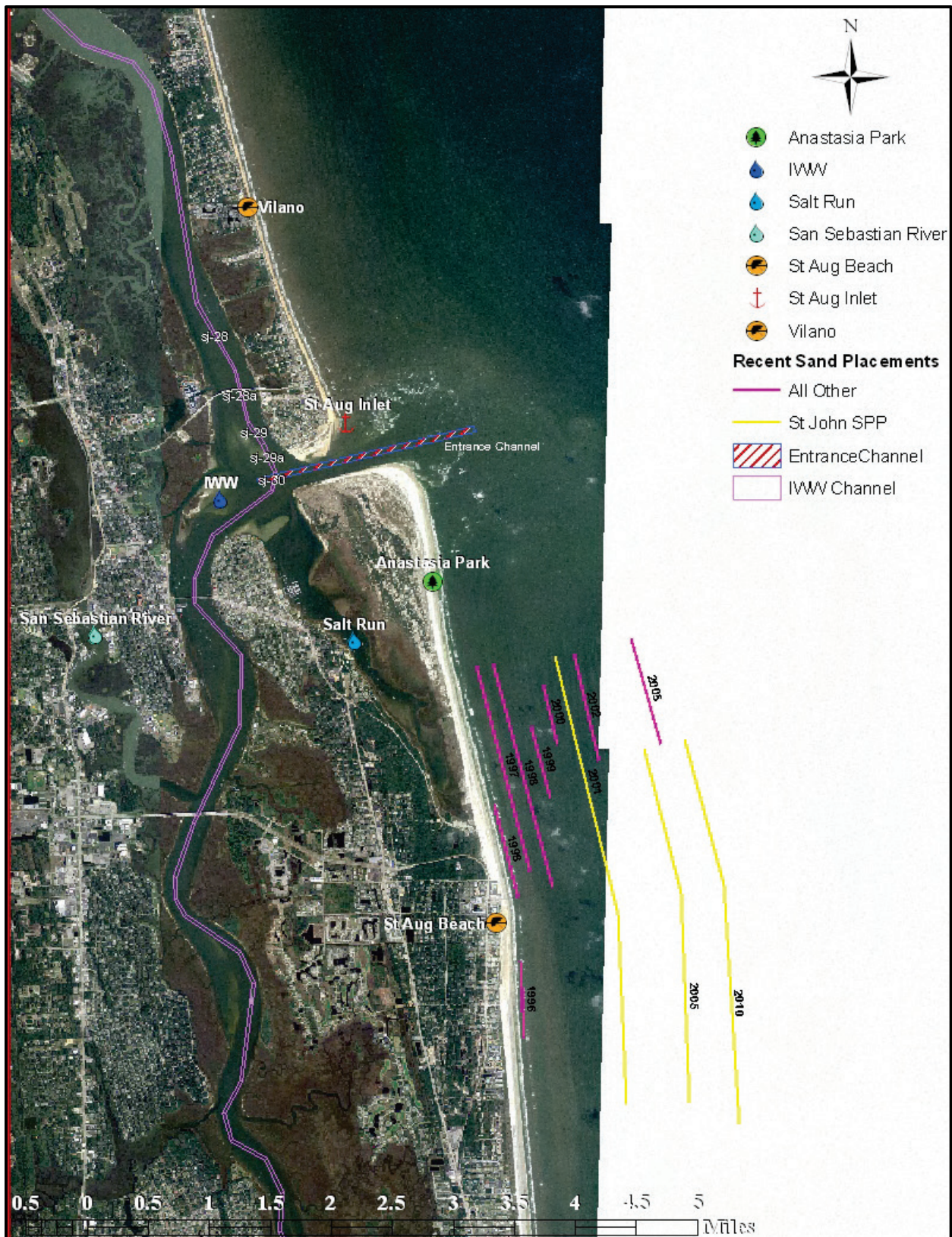


- Create/update the existing sediment budget to better understand how the system is responding to dredging, and to identify needs and sources.
- Link navigation maintenance dredging and placement needs to keep sand in the littoral system.
- Optimize sediment availability and need within the system based on parameters such as quality, quantity, timing, and location.
- If necessary, model the optimized strategy.
- For construction, coordinate navigation channel dredging with beach nourishment, thus sharing costs for construction equipment mobilization and demobilization.
- Monitor effects for future adaptive management.

Dredging and material placement history into GIS

Historical sediment dredging and material placement data from within the project area is vital for sediment budgets. SAJ found that compiling this data into a Geographic Information System (GIS) was useful in analysis and communicating with stakeholders. The history included attributes such as dredging location, placement location, volume, sediment quality, dredge type, etc. Information from the GIS database can be displayed graphically, helping coordination with stakeholders (Figure 4).

Figure 4. Beneficial use and renourishment material placement locations from GIS dredging and material placement history database.



Improvements to the GIS could include compiling financial and permit data, which is often a considerable hurdle to overcome when attempting to combine navigation and shore protection work. Upkeep of these databases is crucial but often overlooked until the need arises to use the data.

2008 RSM strategy in the region

Following the 2005 renourishment of the St. Johns County SPP, it was determined that refinement of the sediment budget and exploration of the use of other sand sources in addition to the ebb shoal were needed. The GIS database containing dredging and material placement history aided both objectives.

Stakeholder discussions

As plans to renourish the St. Johns County SPP began developing in 2008, the Corps, FDEP, Anastasia State Park, and the SPP sponsor (St. Johns County) discussed where additional beach-quality material could be found to reduce the volume needed from the ebb shoal. A key error during these first meetings was that all stakeholders were not present. Notably, the St. Augustine Waterway Port and Beach District and the FIND were not involved in the discussions. Although they later became involved, it is of paramount importance to involve all potential stakeholders as early as possible. All potential stakeholders should be invited to participate in all meetings and encouraged at every opportunity to become involved in the process.

Potential sediment sources identified from the meetings were the Vilano Shoal, Salt Run, and portions of the flood shoal complex. Cuts of the IWW were scheduled and permitted for dredging with their material being used for beach placement. It was decided that the Vilano Shoal also would be investigated, and if found to be beach compatible, would be added to the IWW permit. Portions of the flood shoal would require future geotechnical exploration and permitting, and portions of Salt Run that had been dredged in the past were found to have material too fine for beach placement.

Numerical simulation modeling

Numerical simulation modeling efforts included the following:

- The U.S. Army Engineer Research and Development Center (ERDC) STeady WAVE (STWAVE) numerical wave simulation model (Smith et al. 2001) was applied in 2009 to better understand the relative change to the local wave climate due to dredging activity in the ebb shoal. This modeling facilitated dredging alternatives that allowed for placement of beach quality sand without negatively affecting the natural system.
- The ERDC Coastal Modeling System (CMS) (Lin et al. 2011; Sanchez et al. 2011) was used to identify sediment transport pathways and sediment fluxes across the study area. The CMS application aided in defining the results of various ebb shoal dredging strategies over short time periods.
- The ERDC numerical simulation model GenCade (synthesis of GENESIS and Cascade) (Frey et al. 2012) was developed (2011/2012) to optimize ebb shoal dredging of sand and its subsequent use in the St. Augustine Beach SPP. GenCade is a one-dimensional (1D) model that calculates regional coastal change, including inlets. The model is a combination of GENESIS (a shoreline change model designed for project-scale engineering studies) (Gravens et al. 1991; Hanson and Kraus 1989) and Cascade (a regional alongshore sediment transport model that includes barrier islands and the inlets that separate them) (Larson et al. 2006a, 2006b). The combination of the two models into GenCade, with the addition of the Inlet Reservoir Model which investigates the sediment sinks in inlets (Dabees and Kraus 2005), resulted in a regional model capable of modeling shoreline change up to regional distances on the order of hundreds of kilometers and over longer periods of time than CMS.

In-depth discussion of these modeling efforts is included in a three-part ERDC Technical Report published in 2012 (ERDC/CHL TR-12-14):

- Report 1: St. Johns County; St. Augustine Inlet, FL, Historical Analysis and Sediment Budget (Legault et al. 2012).
- Report 2: St. Augustine Inlet, Florida; Application of the Coastal Modeling System (Beck and Legault 2012a).
- Report 3: Optimization of Ebb Shoal Mining and Beach Nourishment at St. Johns County; St. Augustine Inlet (Beck and Legault 2012b).

Sediment compatibility

For the RSM concept to work along beaches, it must be shown that the sediments to be shared between projects are similar in nature to those

found at the placement location and that they meet FDEP requirements for placement on the beach or in the nearshore. The FDEP determines sediment compatibility during the permitting process. For example, the material to be dredged from the ebb shoal must have characteristics (grain size, silt content, color, etc.) similar to the material found historically on the beach if it is to be used for beach nourishment.

FDEP places limits on the percent silt (fines) that can be placed in state nearshore waters and on shorelines. Dredged material with up to 5% fines can be placed for the purpose of beach nourishment (Florida Administrative Code [F.A.C.] 62B-41.007). Material with up to 10% fines can be placed if the sand has been dredged for navigation purposes and is being beneficially used by placing it on a beach. Material with up to 20% fines can be placed in the nearshore.

An evaluation of sediment needs vs. sources by grain size and silt content is presented in Tables 1 through 3. All information in these tables is based on cross-beach averages. The majority of sediments in the project area are compatible.

Table 1. Sediment properties of St. Johns County, FL, beaches. (Munsell color values: 8 = lightest; 2.5 = darkest).

Location	R-Monuments	Mean grain size (mm)	Silt (%)	Munsell Value
South Ponte Vedra and Vilano Beach	R-86 through R-118	0.35	1	6
Anastasia Island Beach	R-123 through R-133	0.2	1	6
St. Augustine Beach	R-133 through R-151	0.2	0.69	6

Table 2. Summary of St. Johns County, FL, borrow areas sediment properties. (Sand sources based on 2010 data).

Location	Quantity (cubic yards)	Mean grain size (mm)	Silt (%)	Munsell Value
IWW	35,000*	0.44	3.72	6
Flood Shoal	420,000	0.28	1.67	7
Salt Run	No current information. Last investigation revealed fine material (Taylor Engineering).			
Ebb shoal	2,500,000	0.28	1.94	6
Vilano Point	1,000,000	0.25	1.32	6
Northern Off-shore Borrow Area	65,000,000	0.26	2.56	6
Southern Off-shore Borrow Area	30,000,000	0.24	2.63	6

*volume of material from IWW varies significantly year-to-year. A 2013 dredging event took approximately 123,000 cy from several cuts and a portion of the ebb shoal.

Table 3. Compatibility of sediments based on State of Florida requirements.

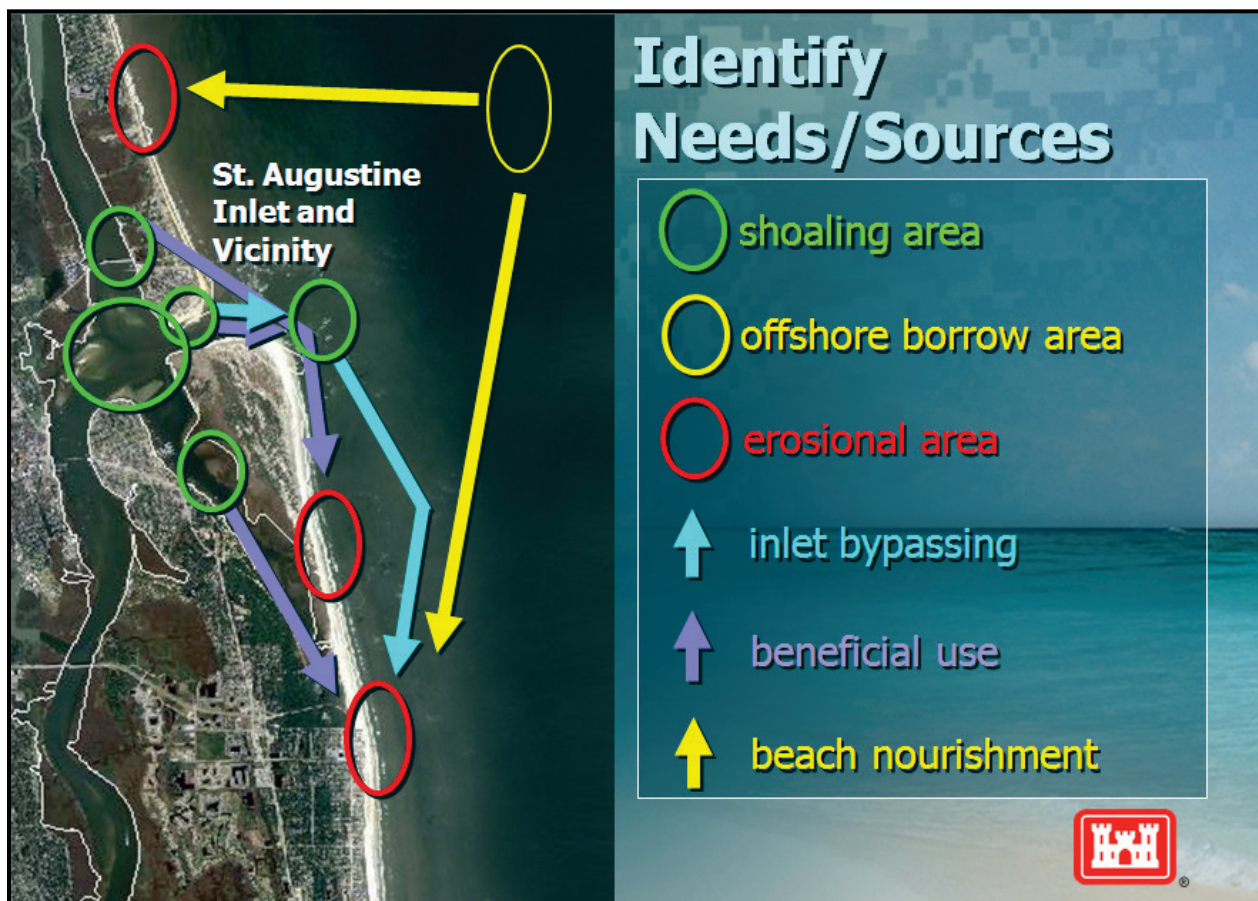
		St. Johns Beaches		
		South Ponte Vedra and Vilano Beaches	Anastasia Island	St. Augustine Beach
St. Johns Borrow Areas	IWW Cut 28	Yes	Not Ideal	Not Ideal
	Flood Shoal	Yes	Yes	Yes
	Salt Run	Insufficient data		
	Ebbshoal	Yes	Yes	Yes
	Vilano Point	Yes	Yes	Yes
	Northern Off-shore Borrow Area	Yes	Yes	Yes
	Southern Off-shore Borrow Area	Not Ideal	Yes	Yes

All sand sources listed in Table 2 meet FDEP F.A.C. 62B-41.007 for either beach or nearshore placement. However, as seen in Table 3, some sources are best used on particular beaches if logistics allow. For instance, while sand from the Southern Offshore Borrow Area could be placed on South Ponte Vedra Beach and Vilano Beach, data indicate that it is best suited to beaches south of the inlet such as Anastasia Island and St. Augustine Beach.

4 Sand Volume Analysis

Sand volume analysis is central to the RSM effort. In Figure 5, green and yellow circles indicate sand sources, and red circles indicate areas where sand is needed in the vicinity of St. Augustine Inlet, FL. The key to an RSM strategy is to get available volumes of sand to where it is needed in the most cost-effective and environmentally responsible way. However, the strategy implementation must be compatible with all Corps authorities, permitting agency requirements, and stakeholder/public acceptability.

Figure 5. Sediment sources and needs, St. Augustine Inlet and vicinity, FL.



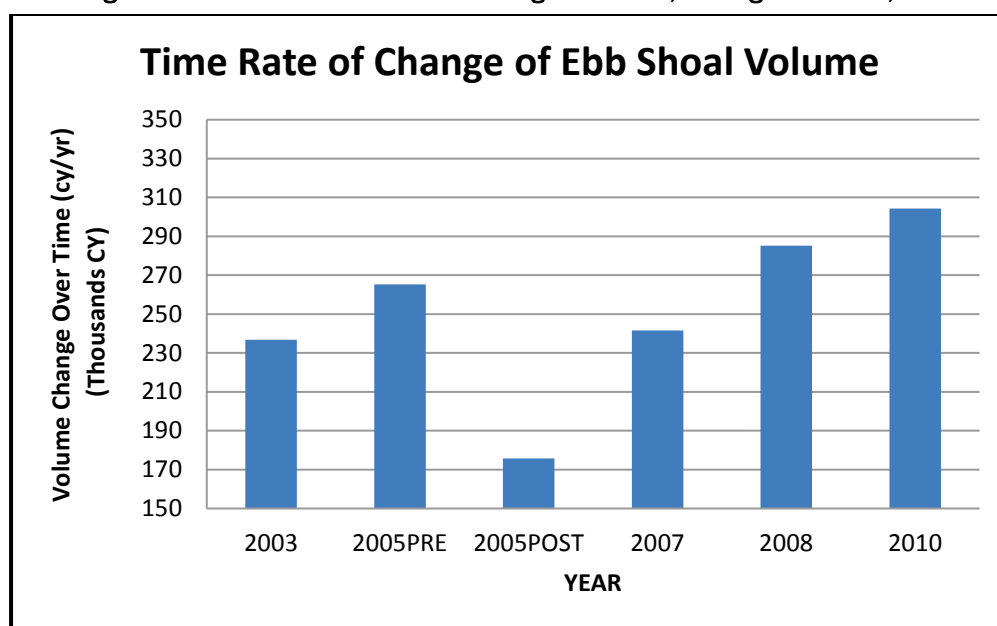
Sand sources

The current sand sources in the project area include navigation sources (IWW and the St. Augustine Inlet channel), the ebb shoal, and shoals adjacent to channels (Vilano Shoal and portions of the ebb shoal). Potential

sources that require additional investigation and permitting include portions of the flood shoal complex, Salt Run, and offshore borrow sources.

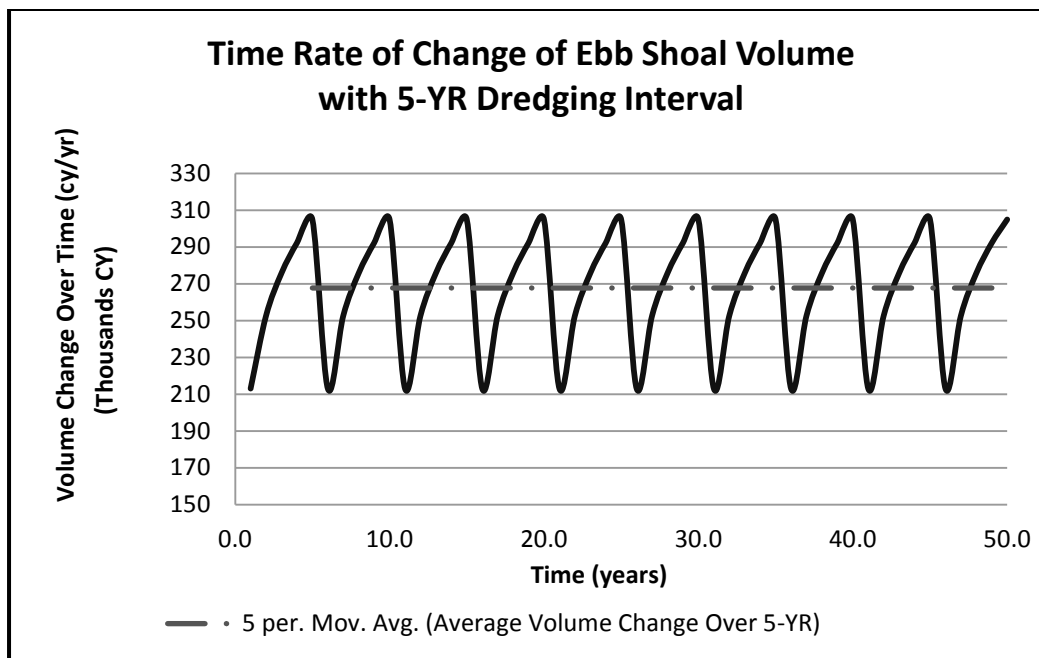
The key to updating the sediment budget and carrying out the scheduled 2012 renourishment was to know how much sand could be dredged from the ebb shoal. The rate of volume change of the ebb shoal was examined before and after a dredging event in 2005. In Figure 6 it can be seen that the rate of ebb shoal growth (accretion) increased over the years following the event from 2005 to 2008. After the dredging event in 2005, a volume increase of $\sim 175,000 \text{ yd}^3/\text{year}$ was observed. By 2010, the rate had grown to over $300,000 \text{ yd}^3/\text{year}$.

Figure 6. Ebb shoal rate of volume change over time, St. Augustine Inlet, FL.



The next step of the modeling effort was directed toward determining how much material could be removed, and how often, while keeping the ebb shoal stable. The numerical simulation models GenCade and the Inlet Reservoir Model were used to evaluate dredging impacts on the ebb shoal system. Figure 7 presents a 5-year interval between dredging events and the predicted rate of recovery after each event. The rates of recovery were based on previously measured rates. The curved line shows the rate of volume change. Sudden drops in the line indicate dredging events. The alternative shown has 1.35 Myd^3 of material removed each event. The dashed line is the average change in volume of the ebb shoal over the 5-year period after a dredging event. In this case, it is $270,000 \text{ yd}^3/\text{year}$.

Figure 7. Ebb shoal rate of volume change over time with dredging, vicinity of St. Augustine Inlet, FL.



This stable recovery of the ebb shoal indicates that the volume of material removed over the chosen cycle would not cause any harm to the functionality of the system.

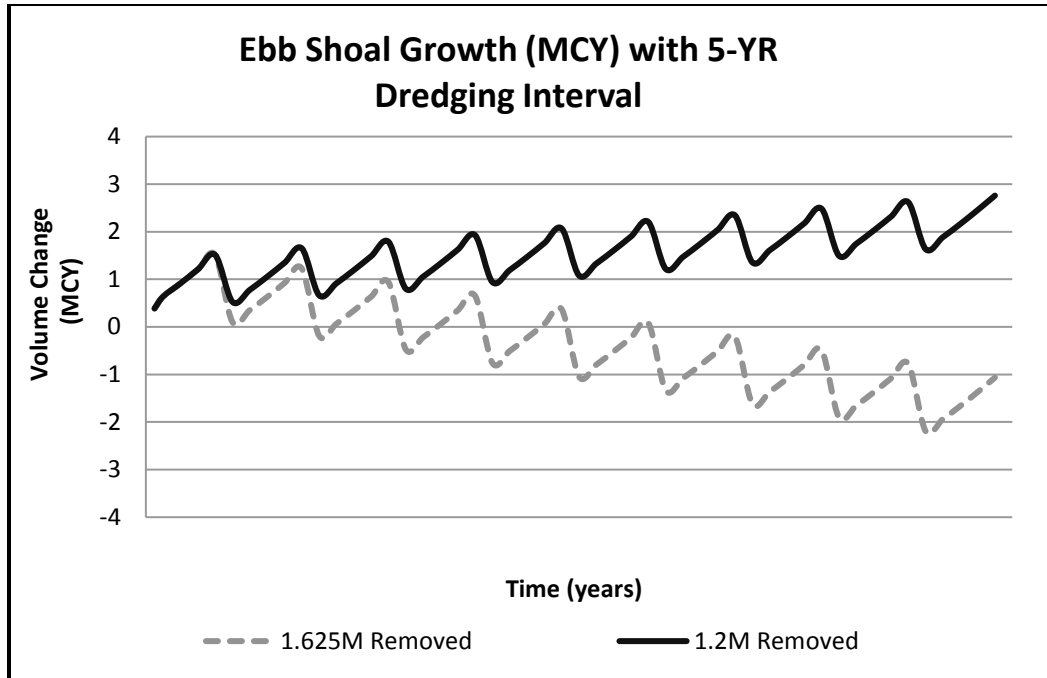
As a sensitivity analysis, dredging volumes greater and less than the 1.35 Myd³ (270,000 yd³/year on 5-year intervals) were analyzed. Figure 8 includes dredging 1.2 Myd³ every 5 years, which is less than the 1.35 Myd³ presented earlier. The result is an overall increase in the volume of the ebb shoal over the 50-year period. The second curve includes dredging 1.625 Myd³ every 5 years, resulting in an overall decrease in the volume of the ebb shoal over the 50-year period.

These results indicated that 270,000 yd³/year (1.35 Myd³ every 5 years) should be bypassed from the ebb shoal.

To evaluate this finding further, Legault et al. (2012) (*St. Johns County, St. Augustine Inlet, FL: Report 1; Historical Analysis and Sediment Budget*) used an Inlet Sink Analysis to determine the effect of the inlet. The Inlet Sink Analysis (Bodge 1999) balances the total rate at which the inlet removes sand from the littoral system with the volume change north and south of the inlet. This method uses the volumetric change rate of the inlet sink and the updrift and downdrift beaches as calculated from profile

data and evaluates these against a range of viable net and gross transport rates for the region. The resulting calculations that balance the known volumetric changes represent a *family of solutions* that each represent a viable budget. These results can be narrowed to better represent the more likely local conditions during the period of the budget.

Figure 8. Ebb shoal volume change over time with dredging, vicinity of St. Augustine Inlet, FL.



Legault et al. (2012) found that north of the St. Augustine Inlet, a maximum erosion rate of 98,800 yd³/year occurred from 1999 to 2010 while south of the inlet the erosion rate was 179,300 yd³/year over the same period. The total *sink* effect of the inlet is therefore approximately 278,100 yd³/year (98,800 yd³/year + 179,300 yd³/year), and this volume could be restored to the beaches. This is in agreement with the previous findings of 270,000 yd³/year. Hence, approximately 278,000 yd³/year can be dredged without destabilizing the system. This represents a volume of approximately 1.4 Myd³ every 5 years. Key to the report conclusions is that approximately 179,000 yd³/year should be placed on the south beaches with the remainder being placed on the beaches to the north.

Note that 179,000 yd³/year is less than the 510,000 yd³/year bypassing rate on which the Federal St. Augustine Beach SPP depends for a sediment source.

To reach consensus among the state and all of the stakeholders regarding a volume to be dredged from the ebb shoal without detrimental effects required extensive coordination. This new information meant that the ebb shoal could no longer be the sole source for the total volume needed for the St. Augustine Beach SPP; therefore, the total volume would need to be augmented with other sources. An RSM strategy was developed that used three sand sources to nourish the Federal St. Augustine Beach SPP: (1) the main channel of St. Augustine Inlet would be dredged first, (2) then a portion of Vilano Shoal, and (3) finally, the ebb shoal would be dredged to meet the 2.1 Myd³ renourishment need of the project. All of the sources would be dredged with a large cutterhead (pipeline) dredge with direct pump-out to the beach. Concerns related to overdredging the ebb shoal were lessened since that source would be the final target, providing only the remaining volume (after dredging the entrance channel and Vilano Shoal) needed to renourish the beach, rather than dredging the entire volume from the ebb shoal as in the two past nourishment events.

This strategy was beneficial to navigation since the channel and problematic Vilano Shoal were targeted for dredging first. Additionally, the St. Augustine Beach SPP funded the work 100%, an important point since shallow draft navigation projects (such as the inlet and the IWW) were not receiving any Federal O&M funding.

This strategy was completed in fall/winter 2012. Approximately 400,000 yd³ of material were dredged from the Vilano Shoal. The outer entrance channel was dredged to a final depth of -32.5 ft where it is currently only authorized to -16 ft. The balance of the material needed was removed from the ebb shoal as planned, to reach a total of 2.1 Myd³. Ultimately, this provided for completion of the St. Augustine Beach SPP, removal of dangerous shoals within the navigation channel, and the dismissal of a law suit regarding the previous borrow area. This translated into approximately \$13,000,000 savings to the navigation program.

Sand needs

Future sand needs in the project area include the authorized St. Augustine Beach SPP and two potential shore protection project beach nourishment areas in South Ponte Vedra Beach and Vilano Beach. The South Ponte Vedra reach is approximately 5 miles in length, and the Vilano reach is approximately 2.5 miles in length, for a total of 7.5 miles maximum. The current St. Johns County HSDR Feasibility Study is evaluating the

feasibility of providing storm damage reduction in these two reaches. If a Federal interest in storm damage reduction such as beach nourishment is determined, it will likely be only for portions of these reaches. For the purposes of this report, a total reach length of 6.5 miles will be used. To calculate the volume of sand potentially required on beaches north of the inlet, a volume per linear foot will be estimated.

For the initial nourishment of the nearest beach nourishment project (the St. Augustine Beach SPP), 4.3 Myd³ of material was placed over 2.9 miles. This equates to 280 yd³/ft. This is a very large number in comparison to average beach nourishment projects. Dean and Campbell (1999) developed an estimate for a successful beach project as 80 yd³/ft placement of compactable sand. For an estimate based on conditions more specific to the project area, the fill density of the Duval County SPP located 32 miles north of St. Augustine Inlet is approximately 60 yd³/ft. For this effort, a density of 120 yd³/ft along 6.5 miles will be assumed for initial nourishment and 60 yd³/ft for renourishments every 5 years for a 50-year total period of Federal participation. This equates to a need of one initial nourishment (6.5 miles × 5,280 ft/mile × 120 yd³/ft) + nine renourishments (6.5 miles × 5,280 ft/mile × 60 yd³/ft) = 23 Myd³ of material.

A volume of 23 Myd³ could be needed for the next 50 years for a potential HSDR project north of the inlet.

South of St. Augustine Inlet, the current St. Augustine Beach SPP has 37 years remaining in its current 50-year period of Federal participation. SAJ is planning to reduce the renourishment volume to 1.625 Myd³ every 5 years based on monitoring surveys indicating that future renourishments may not require such large volumes of sand. Plans are also underway to alternate use of the ebb shoal (Vilano Shoal and the inlet may augment ebb shoal dredging events) with use of an offshore borrow source under development. It is understood that Federal participation in the existing St. Johns County SPP may be extended for an additional period of time. Therefore, a consistent 50-year period of analysis is used to estimate the sand needs in the study area. Over the next 50 years, with a 5-year renourishment interval, 10 renourishment events would take place equaling 16.25 Myd³ of sand.

In total, the study area could require approximately 40 Myd³ of sand over the next 50 years.

Sand availability

Based on past dredging events, Table 4 indicates that approximately 19.75 Myd³ of sand may become available over the next 50 years from *renewable* sources (Vilano Shoal, IWW Cuts, and the Inlet ebb shoal). This means that this entire volume is not immediately available but accretes over time in shoals and channels. This volume is not adequate to meet the potential regional need of 40 Myd³. However, offshore borrow sources are estimated to contain approximately 95 Myd³ of sand, meeting the potential need of the study area. Table 4 shows that development of this offshore borrow source is critical to any future need. With this added volume, the sources are more than adequate to meet the projected future need.

Table 4. Sediment balance for St. Johns County, FL, vicinity of St. Augustine Inlet.

		Volume Available		
		Current (cy)	Renewable (cy/5yr)	50 year volume
Source	Vilano Shoal	-	325,000	3,250,000
	IWW Cuts	-	300,000	3,000,000
	Ebb/St. Augustine Inlet	-	1,350,000	13,500,000
	Offshore Borrow Areas	95,000,000	-	95,000,000
50 year volume available =				114,750,000
Need	St. Johns County SPP	-	1,625,000	16,250,000
	S. Ponte Vedra/Vilano	-	2,300,000	23,000,000
50 year volume need =				39,250,000
50 year balance (available - need) =				75,500,000

Portions of these offshore sources are currently under development and expected to be permitted for use by 2017, the year of the next scheduled re-nourishment of the St. Johns County SPP. Development of an offshore borrow area is anticipated to be necessary to meet the sand needs of the study area, with or without an HSDR project constructed north of St. Augustine Inlet. This is because that accretion of renewable sources is not always dependable. Therefore, it is prudent to develop an offshore source, especially if emergency nourishment becomes necessary following a severe storm.

5 Conclusions and Recommendations

Conclusions

RSM strategies result from combining authorities, funding, permits, and scheduled work, ideally resulting in economic savings while benefitting the region. Often, Corps O&M achieves this spontaneously through institutional knowledge. However, having strategies outlined in advance with key information regarding permits and authorities helps to take advantage of all potential opportunities. It also assists with permitting and other stakeholder involvement, where it can be demonstrated that potential benefits and impacts to the entire coastal system are considered. The following are examples of such strategies. Both the positive and negative aspects of each strategy are highlighted.

RSM Strategy 1 (Multiple Sand Sources)

The 2012 renourishment of the St. Augustine Beach SPP represents one RSM strategy. Three sand sources were used sequentially to nourish the Federal project: (1) the main channel of St. Augustine Inlet was dredged first, (2) next a portion of Vilano Shoal, and (3) finally the ebb shoal was dredged to meet the 2.1 Myd³ renourishment need of the project. All of the sources were dredged with a large cutter-head (pipeline) dredge with direct pump-out to the beach. Concerns related to overdredging the ebb shoal were lessened since that source was the final target, providing the remaining needed volume (after dredging the entrance channel and Vilano Shoal) to renourish the beach rather than dredging the entire volume as in the two past nourishment events.

This strategy was beneficial to navigation since the channel and problematic Vilano Shoal were targeted for dredging first. Additionally, the St. Johns County SPP funded the work 100%. This is an important point since shallow draft navigation projects (such as the inlet and the IWW) currently do not receive Federal O&M funding. The monitoring activity following this work was essential to understand how dredging Vilano shoal impacts the rest of the system and how soon it can be dredged as a sand source again.

This strategy was completed during the fall/winter 2012. Approximately 400,000 yd³ of material were dredged from Vilano Shoal. The outer entrance channel was dredged to a final depth of -32.5 ft where it is currently only authorized to -16 ft. The balance of the material needed was removed from the ebb shoal as planned. Ultimately, this provided for completion of the St. Augustine Beach SPP, removal of dangerous shoals within the navigation channel, and dismissal of a law suit regarding the previous borrow area (ebb shoal). This translated into approximately a \$13,000,000 savings to the navigation program.

RSM Strategy 2 (Nearshore Placement vs. Beach Placement)

A small volume (5,000 yd³) of sand was dredged from the St. Augustine Inlet in Fiscal Year (FY) 2011 as an emergency effort to remove material encroaching on the navigation channel. That material was placed in the nearshore placement area offshore of the St. Augustine Beach SPP (Figure 2). The Corps small hopper dredge *Currituck* was used, resulting in significant O&M savings.

The *Currituck* is able to dredge to a 20 ft depth and could potentially dredge the IWW (and adjacent flood shoal portions), Vilano Shoal, and the entrance channel. The main drawback to using the *Currituck* is that it can only place material in the nearshore, which may not be as beneficial (compared to placement of sand on the dry beach) for storm damage reduction or recreation purposes. It is likely that the St. Johns County SPP sponsor would prefer to fund work resulting in sand placement that would widen the dry beach. However, completing all navigation dredging with a Corps-owned dredge would result in overall cost savings. The *Currituck* is under great demand and is not always available for SAJ work. A new Corps dredge *Murden* has been built to have similar capabilities as the *Currituck*, and with a larger hopper volume, expands the availability of Corps dredges.

All currently permitted sand sources can be dredged with a pipeline with direct pump-out placement (IWW, St. Augustine Inlet Channel, Vilano Shoal, and the ebb shoal). The IWW cuts near the inlet were dredged in FY 2012. Approximately 122,600 yd³ were dredged and placed on the beach of Anastasia State Park. A pipeline dredge was used for this work with direct pump-out to the beach. Cost savings might have resulted if the *Currituck* could have also dredged these IWW cuts. However, the *Currituck* does not have direct pump-out capability and can only bottom dump in the nearshore. Alternately, a pipeline dredge could dredge from all of these

sources with direct beach placement. However, the cost savings of using a Corps-owned dredge would be lost.

RSM Strategy 3 (Hopper Dredge)

Offshore borrow areas (Figure 2) currently under development would likely require the use of a hopper dredge. Development of these sources is essential for potential future projects at Vilano Beach or South Ponte Vedra Beach, as well as being a supplemental or emergency source for the current St. Augustine Beach SPP. This is especially important since most of the navigation sources do not accrete material at a very rapid rate and have not required regular dredging yielding large volumes of material. Possibly, the St. Augustine Beach SPP and other potential projects could be nourished under one contract with CG funds. A hopper dredge could dredge the main channel, thereby also accessing Vilano Shoal. Then the remaining sand requirement could be met using offshore sources. This strategy benefits navigation by clearing the channel and shoal first.

RSM Strategy 4 (Alternate Sources)

It may be advantageous to alternate sources to minimize plant mobilization/demobilization and maximize use of sand impacting navigation. For instance, to renourish the St. Augustine Beach SPP, the IWW, the inlet channel, the Vilano Shoal, and the ebb shoal sources could all four be dredged in one event using a pipeline dredge with direct beach pump-out (or nearshore placement depending on fines content). At the next 5-year St. Augustine Beach SPP renourishment event, offshore borrow sources could be used with a hopper dredge. Additional cost savings would be acquired if any future nourishment projects in Vilano Beach or South Ponte Vedra Beach were nourished at the same time as the St. Augustine Beach SPP. Scheduling would depend highly on dredging needs of the navigation channel and nourishment needs of the beaches.

Recommendation

It is recommended that the sediment budget for the St. Augustine Inlet vicinity be revised periodically as new monitoring data becomes available. The RSM strategies should also be revisited at intervals when either the navigation projects or the St. Johns County SPP has new requirements. A strategy can be selected for implementation based on the project conditions, funding availability, and stakeholder input.

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14. ABSTRACT This report provides a description of Regional Sediment Management (RSM) investigations performed by the U.S. Army Corps of Engineers (USACE), Jacksonville District (SAJ), in the vicinity of St. Augustine Inlet, St. Johns County, FL. Objectives of this study include beneficially using dredged material, coordinating dredging schedules for navigation and storm damage reduction projects, maintaining channels, investigating alternatives to better stabilize beaches, and coordinating improvements to the state's inlet management plan for St. Augustine Inlet. Four RSM strategies developed here are applicable to other regions with multiple projects and sediment-related needs. Strategy 1 (Multiple Sand Sources): Especially beneficial to navigation when the channel can be dredged first. Strategy 2 (Nearshore Placement vs. Beach Placement): Hopper dredge can dump in nearshore or use beach pump-out capabilities (if available). Pipeline dredge can dredge from all permitted sources with direct beach placement. Strategy 3 (Hopper Dredge): Dredge main channel, then access ebb shoals, then obtain remaining sand requirements from offshore sources. Benefits navigation by clearing channel and shoal first. Strategy 4 (Alternate Sources): May be advantageous to alternate sources to minimize mobilization/demobilization and maximize use of sand impacting navigation channel. Scheduling depends on dredging needs of the channel and nourishment needs of the beaches.					
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Sediment transport
Sediment control
Dredging
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