Best management practices for coastal inlets

By

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ABSTRACT

Coastal inlets separate individual barrier islands or barrier spits and adjacent headlands (Hayes and Fitzgerald 2013). Inlets modify longshore transport and store sediment in flood and ebb shoals leading to dynamic adjacent shorelines. For example, 80% to 85% of the beach erosion in Florida can be attributed to inlets (Dean 1991). In some cases, structured inlets are designed to trap sand in a preferred location to minimize interference with navigation and facilitate its removal through dredging. Sound coastal engineering practice requires that this sand be placed on adjacent eroding beaches (NRC 1995) to protect coastal resources.

This paper provides a brief overview of coastal inlet management and identifies Best Management Practices (BMPs) intended to balance human needs for inlet navigation with the natural systems adjacent to tidal inlets. Today's conservation measures, which are a result of considerable monitoring, numerical modeling, and other science-based methods, demonstrate that BMPs improve management of sand resources and reduce impacts associated with tidal inlet dredging. For some inlet conditions, BMPs include use of inlet sediment sinks as cost-effective and eco-friendly sand sources for beach nourishment projects located close to the inlet.

For optimal coastal inlet management, the ASBPA Science and Technology Committee recommends the following BMPs and conservation measures:

- Limit frequency and duration of impacts,
- Follow environmental windows,
- Implement regional sediment management,
- Use beach-compatible sand,
- Conduct pre-, during-, and post-dredging monitoring,
- Modify dredging equipment/practices, and
- Design rechargeable, low-impact inlet borrow sites.

KEYWORDS: Tidal inlet, conservation measures, beach nourishment, dredging, Coastal Barrier Resource Act.

Our nation's inlets and waterways play important ecologic, economic and national security roles by providing entrances to estuarine nursery grounds and cycling nutrients as well as sustaining international and domestic trade and providing harborage. Coastal inlets interact with the natural alongshore drift of sand but also provide critical hydrodynamic linkages of ocean and estuarine waters that sustain coastal ecosystems and communities. A key agency mission of the U.S. Army Corps of Engineers (USACE) is the maintenance of navigable waterways. Optimal inlet and waterway management is vital to sustain the coastal ecosystem and to support commercial and recreational uses of inlet resources.

Adjacent to coastal inlets, the beach and dune system provide important national infrastructure that reduces risk from coastal flooding while enhancing opportunities for tourism and critical habitat restoration. To maintain this critical infrastructure, federal and state governments, as well as local beach communities, commonly support periodic placement of sand on eroding beaches — a process called beach nourishment. USACE beach nourishment projects are typically designed to (a) provide upland protection in the potential future event of a 10-year to 25-year return interval storm, and (b) be maintained over a lifespan of 50 years as authorized and funded by Congress. State and local beach nourishment projects are commonly designed for differing criteria without USACE funding.

Over the last century, many coastal inlets have been jettied and routinely dredged to facilitate navigation. The dredged sediment was often placed in a cheap, offshore disposal area. This removal of sediment from the littoral system has resulted in serious beach erosion impacts at some coastal inlets (Charleston Harbor, SC; Cape Canaveral, FL; Ocean City Inlet, MD). A better management practice is to place dredged sands on adjacent beaches to mitigate beach erosion that may have been exacerbated by the navigation channel; however, implementing this BMP has been a coastal management policy challenge. A difficult and time-consuming challenge for some USACE Districts has been proving that beach placement is a cost-effective and sound engineering practice to avoid downdrift impacts. Local governments may fund the cost difference between offshore placement and a type of placement closer to shore that is beneficial to eroding beaches such as beach nourishment or placement in a nearshore feeder berm (South Padre Island, TX).

For many inlets, beach and inlet maintenance expenditures can be reduced by combining a navigation and beach nourishment project. For example, the USACE Jacksonville District has identified the

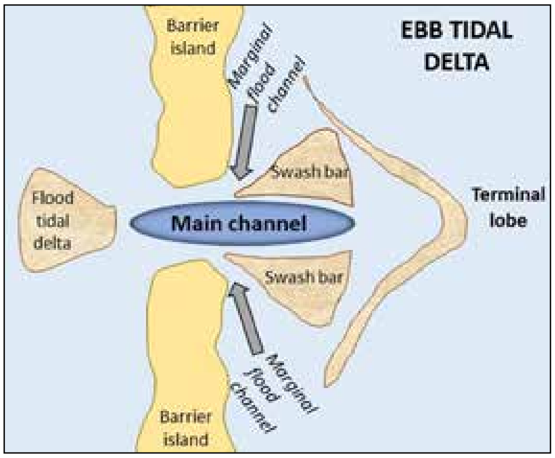
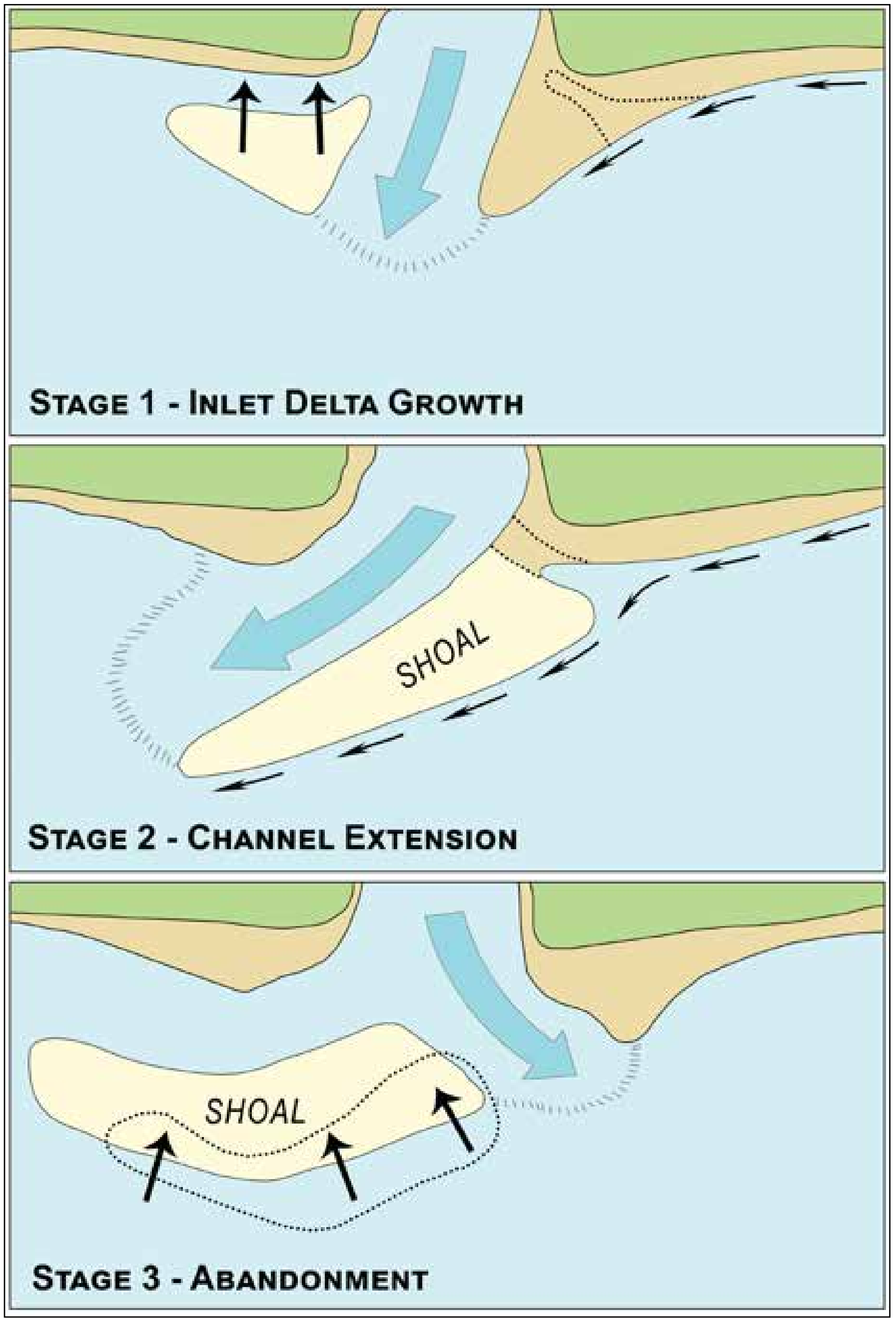


Figure 1 (right). Basic geomorphic features of coastal inlets.

Figure 2 (below). Channel avulsion model modified from Hubbard 1977, courtesy of Coastal Science and Engineering Inc.



potential value to the nation of over $100 million across the southeastern United States by managing sediments across projects and business lines, and optimizing regional dredging activities and schedules (USACE RSM RCX 2019). This concept has such potential to reduce wasteful federal expenditures that a USACE "systems approach" called Regional Sediment Management (RSM) was created. The USACE RSM program receives several million dollars of funding annually to study and encourage projects that save money, treat sediment as a resource, and enhance ecological benefits (USACE RSM 2019a). Similar cost savings can be realized at state and local beach nourishment projects that utilize inlet and waterway sand sources.

Sand used for beach nourishment is ideally as similar as is practically possible to the native sand in terms of composition (carbonate vs quartz), grain size distribution, and color. The sand source can be offshore, nearshore (inlet shoals or navigation channels) or from upland sand mines. Sand sources, which are commonly referred to as "borrow areas," are carefully selected and undergo extensive study for not only sediment quality, but also for avoidance and minimization of ecological impacts.

Each year, the USACE oversees the dredging of over 140 million cubic yards (Mcy) of sediment along the Atlantic, Gulf of Mexico, Great Lakes, and Puerto Rico coasts from about 360 inlets and segments of the Intracoastal Waterway (USACE RSM 2019b). Approximately 100 of these inlets are located at least partially within units established by the Coastal Barrier Resources Act (CBRA) enacted in 1982. Of the 140 Mcy of federally dredged sediment in this region, about 7 Mcy of sand is dredged from federal navigation channels and placed on proximate beaches every year. Other beneficial use of finer sediments include placement elsewhere in the littoral system such as nearshore berms or to restore marsh habitat (USACE RSM 2019a).

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Coastal (tidal) inlets occur at breaks in the shoreline and provide for the exchange of water between the inner shelf and back-barrier environments (Figure 1). Inlets are found within all tidal ranges worldwide. General geomorphological characteristics (Figure 1) include a main inlet channel with marginal side (flood) channels, and sand bodies on both the flood (landward) and ebb (seaward) ends. These flood- and ebb- tidal deltas (also called shoals) act as ephemeral sediment sinks by temporarily retaining sands delivered via longshore and cross-shore transport processes. Inlets with jetties commonly include an additional sediment sink in the form of an updrift fillet — sand impounded against the updrift jetty. Significant weather events commonly alter the forcing mechanisms to reshape the tidal deltas, channels, and fillets. Sediment infilling of the channel can impede navigation and is the primary reason jetty structures are used — to reduce infilling and dredging needs.

Beaches and dunes adjacent to inlets, as well as the inlet shoals themselves, can serve as important habitats for nesting and foraging shore birds, sea turtles, benthic invertebrates, and numerous listed species. In unstructured, natural inlet systems, these habitats are generally more vulnerable to changes brought on by coastal storms and associated inlet migration. Often, the dynamic nature of natural inlet shoals is beneficial in habitat creation. For example, storms sometimes result in the overwash of a flood tidal delta, which may create wide sand flats that are a favorite habitat of shorebirds.

Natural inlet sediment bypassing is a "quasi-steady" process (Bruun and Gerritsen 1959) that transports sand around the inlet. Sediment is transported across the ebb tidal delta in the direction of longshore sediment transport and supplies the downdrift beach. The pathways, frequency, and reliability of natural inlet sand bypassing depend on many factors such as rate of longshore sediment transport, channel depth, seasonal variability, storm processes, tidal vs. wave dominance, and anthropogenic factors. Due to the variability in natural bypassing processes, adjacent beaches often exhibit high erosion and accretion rates (i.e. are highly dynamic). To mitigate these highly variable shoreline fluctuations, inlets are sometimes structured with jetties.

FitzGerald *et al.* (2000) summarized nine models by which sand bypasses inlets. For example, sand bypassing can occur via natural shoal bypassing which involves the episodic release of sand bars from ebb tidal deltas to the downdrift beaches (Kana 2002). One method of shoal bypassing involves channel avulsion (Figure 2), which occurs when the main channel migrates in the direction of littoral drift and begins to infill (Sexton and Hayes 1983). Meanwhile, a secondary channel forms in the outer ebb delta which is oriented in-line with the inlet throat (Traynum and Kaczkowski 2015). At some point, the main channel closes and its sand shoals migrate onshore. The secondary channel takes over as the dominant channel. Coastal inlets have displayed similar, dynamic sediment transport processes throughout geologic history (Hein *et al.* 2016).

In some cases, this channel avulsion process is forced anthropogenically by dredging a shore-perpendicular channel through inlet shoals (e.g. Kana 1989; Erickson *et al.* 2003). This is known as inlet realignment and is discussed in more detail under the BMPs section following.

BEACH NOURISHMENT WITH INLET OR WATERWAY SAND SOURCES

Tidal inlets are dredged for both 1) maintenance of federal navigation channels and 2) as borrow areas for full-scale beach nourishment projects. The use of sediment from navigation channel dredging will be discussed first.

Following National Environmental Policy Act guidance, cost-effective and ecologically considerate uses for dredged sediment have been implemented (Bridges *et al.* 2010) and have been characterized as Natural and Nature-Based Features (Bridges *et al.* 2015). Recognizing sand as a finite resource, the USACE RSM program and state programs (e.g. CSMW 2019) encourage dredged sediments to be selectively placed for the most beneficial outcome. Such projects are often referred to as Beneficial Use of Dredged Material (BUDM) projects.

The Florida Statutes (a) cite "it is in the public interest to replicate the natural drift of sand which is interrupted or altered by inlets to be replaced" and (b) require at least "reasonable effort to place beach-quality sand from construction and maintenance dredging and port-development projects on adjacent eroding beaches" (Section 161.142, Declaration of public policy relating to improved navigation inlets).

These federal and state programs encourage planners to place sand from the maintenance dredging of harbors, inlets, and waterways along, or seaward of, the adjacent oceanfront shorelines of barrier islands. This practice helps to maintain healthy beaches and littoral sediment resources in the sand-sharing barrier-inlet system (Beck 2019). This is a common operating procedure when the lowest cost disposal area is the adjacent beach (e.g. Folly River, SC; St. Mary's King Bay, FL; Tampa Harbor, FL) or nearshore placement areas (e.g. Barnegat Inlet, NJ; Burns Harbor, IN).

Inlets or waterways are also dredged to provide a sufficient volume of sediment (on the order of 1 Mcy) for a large-scale beach nourishment project. In some cases, the navigation channel is included within the inlet borrow area. This practice allows for the combination of projects (navigation dredging and beach nourishment) to reduce overall costs of maintaining beaches and navigation projects. For example, projects of this nature occur in the U.S. southeast in Florida (John's Pass, St. Augustine Inlet, Palm Beach Harbor, Ft. Pierce Inlet, St. Lucie Inlet, Ponce Inlet, and various Intracoastal Waterway projects), North and South Carolina (Carolina Beach, NC; Folly River, SC), and New Jersey (Hereford Inlet, NJ).

The sand volume obtained from typical navigation channel dredging and placed on an adjacent eroding beach is usually not sufficient to offset inlet impacts and maintain the beach. As depicted in Figure 1, inlets commonly have other sediment sinks beyond the maintained inlet channel. However, navigation dredging footprints are commonly widened or otherwise expanded to provide additional sand needed for beach nourishment.

The combination of navigation channel maintenance, dredging, and beach nourishment can provide significant cost saving benefits. Consider the scenario of two proximal, yet independent, projects. In the first, dredged sediment from a coastal harbor is placed in an offshore disposal area where sand may be lost from the littoral system. In the second, nourished sand for the eroding beach downdrift of this harbor is dredged from an offshore borrow area. A more sustainable approach could be combining these two projects such that beach-quality sand dredged from the harbor is placed on or near an eroding downdrift beach. Considerable cost savings are typically realized when the projects are combined: 1) mobilization costs are reduced, 2) at least some of the project cost is covered by navigational funding (to maintain the channel), and 3) some of the project cost is covered by the proximal storm damage reduction project (beach nourishment) funding.

At some U.S. inlets, management programs use fixed sand bypassing equipment to reduce the effects of structures (e.g. Indian River Inlet, Delaware; Lake Worth Inlet, Florida) where sediments are transferred from the accreting updrift side to the shoreline downdrift of the inlets.

COMPARISON OF INLET AND OFFSHORE BORROW AREAS FOR BEACH NOURISHMENT

The use of inlet borrow areas for beach nourishment generally results in lower immediate costs and shorter duration dredging projects than use of borrow areas located farther offshore. One of the most significant cost factors in a dredging/beach nourishment project is fuel consumption by the vessels used to pump sand from the borrow area to the beach (e.g. USACE 2019a; 2019b). Thus, the farther a borrow area is located from the beach placement site, the higher the project cost. Another significant cost factor is salary and insurance for crew members. Offshore borrow areas generally require additional vessels, pumps, and crew members to manage equipment and sand transport between the borrow area and the beach. Inlet borrow areas generally require fewer vessels/crew and less pumping power (fuel).

Offshore borrow areas have the disadvantage that they are not protected from deep ocean wave energy, thereby increasing safety hazards (risk) as well as the likelihood of increased down time or "weather days." Both factors result in lower productivity, longer project duration, and higher cost. Inlet borrow areas are generally more protected from open-ocean processes because they are sheltered from deep ocean wave energy due to shoreline orientation. Inlet borrow areas are often located "inside" inlet shoals which dissipate wave energy before it reaches the channel. Use of inlet borrow areas results in increased dredging production, reduced project duration, and decreased cost compared to offshore borrow areas.

Environmental impacts comparison

A borrow area located in an active ebb-tidal shoal will likely be in-filled by longshore sediment transport, while an inactive, offshore area located outside the littoral zone will not (Rosov *et al.* 2016). As described above, dredging/beach nourishment projects that utilize offshore borrow areas typically have a longer construction duration due to the distance between the beach and borrow area, as well as the increased risk. Projects with a shorter construction duration have fewer environmental impacts (less impact to fisheries, recreation, and aesthetics; fewer air emissions, noise, endangered species vessel strikes and entrainment) (USACE 2019a). Table 1 compares the broad impacts associated with use of an inlet borrow area versus an offshore borrow area.

BEST MANAGEMENT PRACTICES (BMPS)

Since the passage of the National Environmental Policy Act in 1969, federal resource agencies have provided technical assistance to the USACE for dredging activities. Agencies such as NOAA National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) work with the USACE and dredging industry to identify numerous conservation measures and Best Management Practices (BMPs) to minimize dredging impacts. State-level policies have also been implemented to ensure regional interests are considered.

For optimal coastal inlet management, the ASBPA Science and Technology Committee recommends the following conservation measures and BMPs:

- Limit frequency and duration of impacts,
- Follow environmental windows,
- Implement regional sediment management,
- Use beach-compatible sand,
- Conduct pre-, during-, and post-dredging monitoring,
- Modify dredging equipment/practices, and
- Design rechargeable, low-impact inlet borrow sites.

A detailed discussion of each of these recommendations follows. We also suggest early and frequent consultation with state and federal resource and regulatory agencies. Borrow area design and other project elements can often be modified to avoid and minimize impacts to ecological resources when the design engineers have knowledge of resources and potential impacts.

Limit frequency and duration of impacts

Numerous studies recommend that to minimize ecological impacts, the frequency and duration of nourishment projects should be limited (Rosov *et al.* 2016). For example, a comparison of inlet and offshore borrow areas for Wrightsville Beach, NC, found that the inlet borrow area would require about 45 days of dredging for one cutterhead dredge; whereas the offshore borrow area would likely use two hopper dredges working concurrently for 54 days each (USACE 2019b). This study cited environmental benefits for using inlet sand rather than offshore sand including

Fewer dredging days with a cutterhead dredge as opposed to two hopper dredges. This reduces air emissions, noise, endangered species vessel strikes and entrainment, recreation, and aesthetics; and

Smaller acreage of benthic and water quality alterations and in the same, previously dredged area as opposed to larger and new impacts each with dredging event.

It was concluded that the inlet borrow area was environmentally preferable to the offshore sand source (USACE 2019b).

Follow environmental windows

One example of a relatively routine conservation measure developed by USACE, the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the dredging industry is environmental windows. Environmental windows are time periods during which dredging is less likely to result in physical disturbance of nesting shorebirds or turtles, and spawning fish via habitat destruction, detrimental effects of suspended sediments, turbidity, sedimentation, and hydraulic entrainment (Suedel *et al.* 2008). Dredging is restricted during critical time windows when at-risk environmental resources are present.

An example of an environmental window is for hopper dredging in the southeastern United States, which is generally allowed during the winter months of December through March, when sea turtle abundances are known to be low in inshore waters; while turtles are abundant during the summer nesting season. NMFS also encourages wintertime dredging to protect Essential Fish Habitat (ESF) allowing benthic community recovery (6 months-1 year) by the time peak fish use for foraging resumes in the surf zone.

Environmental dredging windows are designated during the state and federal permitting process (e.g. via a regional NMFS Biological Opinion) after considering the available biological and dredging data (SARBO 1997; GRBO 2003). Environmental windows are generally included as conditions of a permit that is issued to the project applicant.

Environmental windows are challenging because restricting dredging to winter months complicates dredging schedules and causes safety issues for dredge crews typically working under severe winter sea conditions (Dickerson *et al.* 2007) thereby increasing costs, particularly for offshore borrow areas (Childs 2015). Additionally, various species' windows may overlap allowing only narrow windows of opportunity or insufficient time for a dredging project to occur.

Implement Regional Sediment Management

Until the 1970s, inlet management practice included offshore disposal of dredged material, which interrupted natural bypassing and reduced sand supply to downdrift beaches (Dabees and Moore 2011). Today, best management practices are changing to beneficially use dredged sediment, but many states continue to dispose of nearshore sediments in ocean disposal management areas (USACE RSM 2019a). Cost-effective and ecologically considerate management practices now recommend mitigating the erosion of beaches adjacent to inlets (Beck 2019) via bypassing dredged sediment to those adjacent beaches.

A sand-sharing system such as that of coastal inlets and adjacent beaches has a delicate balance that is easily disrupted by removal of littoral sands from any part of the system (Beck 2019). Because the relationship between excessive sand removal of shoal volume to beach erosion has been well-described (Dean 1991; Trudnack 1997; Finkl 2012; Garel *et al.* 2014) numerous studies have examined best management practices toward sustaining a positive interconnectivity between beaches and inlets (Walther and Douglas 1993; Mehta *et al.* 1996).

Seabergh and Kraus (2003) summarize management practices for natural and engineered inlet bypassing. These authors maintain that engineered bypassing could work to harmonize the human requirements of maintaining channels for navigation with the natural, or historical, sediment-sharing requirements between inlets and beaches. However, sand obtained from inlet navigation channel dredging alone is rarely sufficient to offset inlet-induced beach erosion, which must be supplemented by placement of sand obtained from other sources to maintain the beach.

The USACE and its partners recognize that sediment is a valuable resource and implement RSM measures to balance the need for navigation with protection of coastlines and natural resources. Dredging and management decisions are guided by numerous factors, such as cost as mentioned above, but perhaps most importantly, the local sediment budget and science-based metrics for best use of the sediment. Shoreline impacts are minimized through a systemwide understanding of sediment dynamics of the area (Garel *et al.* 2014).

The USACE St. Augustine Inlet, St. John's County, Florida, project is an example of a federal navigation project located within a CBRA unit and a USACE coastal storm damage reduction (beach nourishment) project located downdrift of the navigable channel. This project has implemented a science-based sediment management strategy to beneficially use dredged material, coordinate dredging schedules for navigation and storm damage reduction projects, maintain channels, investigate alternatives to better stabilize beaches, and coordinate improvements to the state's inlet management plan (Schrader *et al.* 2016). BMPs developed for this project are applicable to other regions with multiple projects and sediment-related needs.

Considerable numerical modeling and science-based methods have been undertaken to determine BMPs that improve management of sand resources of coastal inlets and reduce dredging impacts (e.g. Kraus 2000; Dabees and Moore 2011).

State-level RSM policies have also been implemented. For example, the state of Florida encourages that all dredged inlets have a state-approved Inlet Management Plan (IMP). These plans establish strategies to best manage sand resources, including bypassing activities for placement of beach quality sand on adjacent eroding beaches of the inlet. The intent of the IMP strategies is to maintain the inlet for navigation or flood control while concurrently replicating the natural drift of sand to "address the beach erosion caused by inlets" by maximizing inlet sand bypassing, balancing the inlet sediment budget consistent with the Florida Statutes (Section 161.142, Declaration of public policy relating to improved navigation inlets).

Use beach-compatible sand

When sediment is placed on a beach, the character of the placed sand (i.e. borrow sediment) ideally matches the natural or native beach sand. Sand characteristics include grain size, composition, and color. Grain size is an important factor in the slope of the beach, compaction, and sediment transport pathways (on- and offshore as well as alongshore), the extent of fine sediments is the primary factor associated with turbidity during dredging and storms after sand placement. NMFS recommends using beach compatible sand to limit turbidity at the borrow area and avoid Essential Fish Habitat impacts in the nearshore associated with burrowing organisms and associated feeding by fish (J. Daly, personal communication 2013). Composition and color are important for reflectivity, which influences the temperature of the sediment and substrate. Temperature regulates the sex of sea turtle hatchlings (Mrosovsky 1994).

Exact requirements for beach compatible sediments approved for placement often vary by project type and state. For example, Florida's "Sand Rule" is prescribed by Section 62B-41.007(j) of Florida Administrative Code, which cites that beach-compatible sand (a) "shall be similar in color and grain size distribution …to the native beach sediment, and (b) is limited to sediment with a mean grain size between 0.062 mm and 4.76 mm, and may not contain more than 5% fine "gravel" — (4.75 mm) or fine-sized (0.063 mm) material by weight. In North Carolina, sand obtained from a navigational channel is permitted to contain up to 10% fine sediment. The State of California uses a "80/20" coarse-to-fines ratio when determining whether sand will be permitted for beach placement.

Additional study and consultation are needed to refine some state sediment regulations for beach and nearshore placement to optimize the balance between reduced turbidity at the dredging site, the final composition of the placed sediment, and other environmental factors (Maglio *et al.* 2015). We recommend additional research to consider whether regulations should consider fine percentages on the constructed beach rather than, or in addition to, the borrow area.

Conduct pre-, during-, and post-dredging monitoring

Both physical and biological multi-year monitoring programs are commonly required by state and federal regulatory agencies to document project performance, potential impacts to ecological resources, borrow area infilling rates, and to provide a basis for understanding sediment processes. In addition to physical monitoring (e.g. bathymetric surveys), a common permit condition for dredging projects is the long-term monitoring and recovery of benthic invertebrates, coral, seagrass, shorebirds, sea turtles, and other coastal species. Some of these biological monitoring efforts continue for 10 or more years after construction (USACE 2018).

During dredging, many states require that turbidity levels are monitored at the dredging site in the borrow area, along the transit path between the borrow area and the beach, and at the beach nourishment site. In addition, real-time dredge position monitoring is a common requirement on both federal and non-federal dredging projects. The USACE National Dredging Quality Management Program is dedicated to providing web-based tools for the dredging manager to monitor dredge position remotely (https://dqm.usace.army.mil/). This is intended to assure avoidance of adverse impacts upon ecological and physical resources during dredging operations.

A technical challenge to inlet management is the high cost of obtaining frequent hydrographic survey data over an entire inlet system including the ebb and flood shoals. State permits typically require such high-resolution spatial and temporal hydrographic monitoring of inlet borrow areas, which are used to calculate infilling rates and determine changes in shoal positions (e.g. unpublished South Carolina Department of Health and Environmental Control Office of Ocean and Coastal Resource Management permit to Charleston County Park and Recreation Commission 2013). For example, Florida's inlet management plans set forth a long-term physical monitoring protocol for the inlet and adjacent beaches to determine how target bypassing quantities and placement areas may need to adapt over time (R. Clark, personal communication, 6 December 2019). New technologies, such as Light Detection And Ranging (LIDAR) has shown some promise for the collection of less expensive, more frequent surveys; however, turbidity conditions at inlets and the need to combine multiple monitoring efforts to realize the cost savings often make LIDAR more of a logistical challenge for local communities as compared to traditional hydrographic surveying techniques.

In many cases, the state-of-the-art of numerical modeling has not sufficiently advanced to provide high certainty in the characterization of coastal sediment transport and associated geomorphology — particularly surrounding inlets and the use of ebb shoals as a borrow area. This is primarily due to the high cost and absence of sufficient field measurements to calibrate and verify the models. However, fundamental conservation of mass principles can be reasonably employed with historical survey data to assess impacts via formulation of an inlet sediment budget under existing conditions and with potential modifications. Use of an ebb shoal as a borrow area is likely to at least temporarily reduce natural bypassing across the ebb shoal as the borrow area refills. Post-construction monitoring of the ebb shoal and adjacent beaches can provide a basis to (a) assess the ebb shoal borrow area infilling rate and associated impacts upon downdrift beaches due to use of ebb shoal as a borrow area, and (b) formulate potential future projects using the ebb shoal as a borrow area.

Modify dredging equipment and practices

To minimize entrainment of fisheries during the dredging process, contractors may be required to modify equipment or the dredging intake process (USACE 2018). For example, special permit conditions may dictate that suction of sediment may not occur until after the dredge is at the bottom of the waterway and must be turned off while in the water column. In addition, careful placement of the dredge, anchors, lighting, and supporting equipment is required during mobilization and demobilization to avoid impacts or physical damage to habitats (e.g. live/hard bottom, corals, sandy bottom, marsh/seagrass vegetation) from the anchor, pipeline, and cables.

Design rechargeable, low-impact inlet borrow areas

Inlet channels and ebb-tidal deltas have historically been, and continue to be, utilized as sand sources for beach nourishment due to their proximal location to eroding beaches and their renewable nature. Finkl *et al.* (2007) suggested that large, tidally dominated inlets are optimal sediment resources as their size and proximity to the shore reduce effects on sediment bypassing and wave sheltering on adjacent beaches; this is particularly valid for inlets that are very much tidally dominated, with massive historically expanding shoals and relatively minimal natural bypassing. Borrow area design (depth, location) plays an important role in the infilling rates and subsequent (a) physical and biological recovery of inlet borrow areas, and (b) subsequent erosion rate of downdrift beaches. As discussed above, inlet borrow areas are located within the littoral system — the zone of active sediment transport along the coast — and can serve as renewable sand sources when managed appropriately. By contrast, offshore borrow areas are generally not renewable/rechargeable and result in new biological impacts for each dredging event (see Table 1). By implementing BMPs frequently including supplemental beach nourishment, coastal inlet management can balance the sediment budget to the benefit of both the inlet and the adjacent beaches (Dabees and Moore 2011).

In general, when the post-dredging physical conditions resemble the pre-dredging conditions, repopulation of biota can be expected (Rosov *et al.* 2016). Potential long-term physical and biological impacts could occur if dredging significantly changes the physiography of shoals — as commonly occurs for an offshore borrow area. Sediment removal has the potential to alter seabed topography, particularly if sediment removal in the borrow area results in a deep hole. Numerical modeling of morphological changes associated with dredging has been used to show borrow area location can reasonably predict whether infilling of an excavated area will occur (CSA International *et al.* 2009).

The location of a borrow area in an active inlet shoal allows, via the process of natural sand bypassing, for ebb tidal deltas to be self-replenishing (Kana *et al.* 2014). When the updrift edge of an ebb delta is dredged, new sand will naturally infill the dredged area due to local forcing conditions. Dredging sand from the portion of the shoal facing the predominant longshore current direction (i.e. the leading or updrift edge of the shoal) will facilitate a relatively rapid recovery of the physical condition of the shoal feature via interruption and trapping of natural bypassing, and also will increase the rate of recovery of the benthic infaunal community (CSA International *et al.* 2009). This is due primarily to the physical conditions that would lead to a net long-term deposition and faster infilling rates of these dredged areas. The second most desirable location for dredging would be the shoal crest, followed by the trailing edge (Johnson and Nelson 1985). Bergquist (2008) recommends locating nearshore borrow areas at the downdrift ends of barrier islands where beach-compatible sands tend to accumulate.

The configuration and depth of the borrow site is also important. Bergquist (2008) offered several recommendations for borrow areas designed in South Carolina: dredge to less than 3 m below grade; avoid creating deep pits at borrow site; and design borrow area with shallow dredge cuts to encourage rapid recovery (shallowly dredged borrow sites tend to re-fill rapidly with beach compatible sand). Other commonly implemented BMPs include: remove a low volume of sediment relative to the total ebb shoal volume; and observe buffer areas around historic properties such as shipwrecks or other anthropogenic objects such as pipelines or cables.

Table 1.
Comparison of inlets vs. offshore borrow areas (modified from USACE 2019a; 2019b)

Inlet	Offshore
Close proximity to beach = Fewer vessels/crew & pumping requirements = Lower cost	Long distance between borrow area and beach = More vessels/crew & pumping requirements = Higher cost
Often leverage navigation dredging funds to reduce project cost share	Do not leverage navigation dredging funds
Typically more protected from ocean wave energy, therefore fewer down weather days for dredging and shorter project duration	Typically less protected from ocean wave energy, therefore more down weather days for dredging and longer project duration
Shorter construction duration = less impact to fisheries, recreation, and aesthetics; fewer air emissions, noise, endangered species vessel strikes and entrainment	Longer construction duration = more impact to fisheries, recreation, and aesthetics; greater air emissions, noise, endangered species vessel strikes and entrainment
Renewable sand source — via capture of longshore transport	Finite sand resource
Repeatable dredging footprint (predictable impacts)	New dredging footprint for each event (new impacts)
Potentially smaller acreage of benthic and water quality impacts	Potentially larger acreage of benthic and water quality impacts
Projects are designed and permitted to avoid "starving" (reducing amount of sand available to) downdrift beaches temporarily by managing sediment as a regional resource	Projects are designed and permitted to avoid adversely altering the nearshore bathymetry and wave patterns
Faster benthic recovery rates	Offshore borrow areas tend to infill with finer sediments (more silt/clay, less carbonate) following dredging making benthic recovery time slower (Coen 1995)
Recycles beach sediment in littoral system	Add "new" sand to littoral systems
Navigation use benefits	No navigational use benefits
Limited water quality impacts to nearshore marine resources	No water quality impacts to nearshore marine resources

Inlet realignment

As described above, inlet shoal bypassing is a natural process that allows for the episodic release of sand bars from ebb tidal deltas to the downdrift beaches. Occasionally, the natural shoal bypassing process is forced anthropogenically by dredging a shore-perpendicular channel through inlet shoals. This is a less intrusive inlet management practice than jetty construction, and it is well understood after many decades of study (e.g. Kana *et al.* 2013). Forced shoal bypassing has benefits for navigation and for the downdrift beaches.

Welsh and Cleary (2007) reviewed the results of a realigned, unstructured inlet in North Carolina and found that maintenance dredging is helpful in maintaining the requisite tidal prism and flushing capacity to attain equilibrium (i.e. maintains inlet's hydrodynamic "health"). Cleary and FitzGerald (2003) analyzed dredging-induced tidal prism changes and resultant sedimentation at Mason Inlet, North Carolina, and found that inlet realignment and basin dredging increased the inlet's tidal prism substantially, while reducing the prism at adjacent inlets connected through the Atlantic Intracoastal Waterway. Additionally, relic ebb-tidal delta sand was noted as having migrated onshore, providing substantial nourishment for years to decades thereafter.

SUMMARY

This paper provides a brief overview of multiple studies and governmental collaborations that have provided for the maintenance of navigable inlets while protecting valuable coastal resources over the last several decades. Best Management Practices (BMPs) are followed today to harmonize human needs for navigation at coastal inlets with the associated natural systems. Considerable numerical modeling and science-based methods — as cited in the references below — have been undertaken to determine BMPs that improve management of sand resources of coastal inlets and reduce environmental impacts of dredging and inlet management.

The USACE Dredging Operations and Environmental Research Program (https://doer.el.erdc.dren.mil/) investigates and documents the details of many of the dredging BMPs described above. The program was created to balance the economic, engineering and environmental needs of USACE dredging projects. The program has developed a database of over 3,000 peer reviewed papers and reports (grey literature) that have investigated potential environmental impacts and benefits of dredging (https://dots.el.erdc.dren.mil/databases5.html). We encourage those interested in specific topic areas to explore this database.

REFERENCES

Beck, T.M., 2019. "Review of Coastal Tidal Inlet Morphodynamics in the Context of Barrier-Inlet Sustainability." U.S. Army Corps of Engineers, Engineer Research and Development Center report, *ERDC/CHL SR-19-6*, August 2019, 61.

Bergquist, D.C., 2008. "Change and recovery of physical and biological characteristics at beach and borrow areas impacted by the 2005 Folly Beach renourishment project." *South Carolina State Documents Depository*.

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., M.E. Bates, Collier, Z.A., Fischenich, J.C., Gailiani, J., Leuck, L., Piercy, C.D., and J.D. Rosati, 2015. "Use of natural and nature-based features (NNBF) for coastal resilience." U.S. Army Engineer Research and Development Center, Environmental Laboratory, Coastal and Hydraulics Laboratory, *ERDC SR-15-1*, 479.

Bridges, T.S., Gustavson, K.E., Schroeder, P., Ells, S.J., Hayes, D., Nadeau, S.C., Palermo, M.R., and C. Patmont, 2010. "Dredging processes and remedy effectiveness: Relationship to the 4 Rs of environmental dredging." *Integrated Environ. Assessment and Management*, 6(4), 619-630.

Bruun, P., and F. Gerritsen. 1959. "Natural bypassing of sand at coastal inlets." *J. the Waterways and Harbors Division*, ASCE, 85(4), 75-107.

Childs, J.L., 2015. "Dredged material management categories for tracking beneficial use." U.S. Army Corps of Engineers, Engineer Research and Development Center report, ERDC-TN-DOER-R22, 10p.

Cleary, W.J., and D.M. FitzGerald, 2003. "Tidal inlet response to natural sedimentation processes and dredging-induced tidal prism changes: Mason Inlet, North Carolina." *J. Coastal Research*, 1018-1025.

Coen, L.D., 1995. "A review of the potential impacts of mechanical harvesting on subtidal and intertidal shellfish resources." Charleston, SC: South Carolina Department of Natural Resources, Marine Resources Research Institute, 46p.

CSA International, 2009. "Analysis of Potential Biological and Physical Impacts of Dredging on Offshore Ridge and Shoal Features." Prepared in cooperation with Applied Coastal Research and Engineering Inc., Barry A. Vittor & Associates Inc., C.F. Bean LLC, and the Florida Institute of Technology for the U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, VA. OCS Study MMS 2010-010. 160p. + apps.

CSMW, 2019. California Division of Boating and Waterways, Coastal Sediment Management Workgroup (CSMW), https://dbw.parks.ca.gov/?page_id=29239, accessed 16 December 2019.

Dabees, M.A., and B.D. Moore, 2011. "Evaluation of inlet management practices at navigation inlets in southwest Florida, USA." *Proc. 32nd Conference on Coastal Engineering*, Shanghai, China, 2010. 1(32), 89. DOI: https://doi.org/10.9753/icce.v32.sediment.89

Dean, R.G., 1991. "Impacts of global change: engineering solutions." In: *Our Changing Planet: Joining Forces for a Better Environment*. Proc. of Symposium on the Commemoration of the 20th Anniversary of the Graduate College of Marine Studies, University of Delaware, Newark, Delaware, 13-17.

Dickerson, D., Theriot, C., Wolters, M., Slay, C., Bargo, T., and W. Parks, 2007. "Effectiveness of relocation trawling during hopper dredging for reducing incidental take of sea turtles." *2007 World Dredging Conference*. 509-530.

Erickson, K.M., Kraus, N.C., and E.E. Carr, 2003. "Circulation change and ebb shoal development following relocation of Mason Inlet, North Carolina." *Proc. Coastal Sediments 2003*, World Scientific Publishing and East Meets West Productions, Corpus Christi, TX ISBN-981-238-422-7, 13p.

Finkl, C.W. 2012. "Pitfalls of ebb-shoal mining." In Cooper, J.A., and O.H. Pilkey, *Pitfalls of Shoreline Stabilization: Selected Case Studies*, 37-52. Springer Science and Business Media.

Finkl, C.W., Benedet, L., Andrews, J.L., Suthard, B., and S.D. Locker, 2007. "Sediment ridges on the west Florida inner continental shelf: Sand resources for beach nourishment." *J. Coastal Research*, 143-159.

FitzGerald, D.M., Kraus, N.C., and E.B. Hands, 2000. "Natural Mechanisms of Sediment Bypassing at Tidal Inlets." Vicksburg: USACE Research and Development Center, 12p.

Florida Statute 161.142 "Declaration of public policy relating to improved navigation inlets." https://www.flsenate.gov/Laws/Statutes/2018/161.142 accessed 22 February 2020.

Garel, E., Sousa, C., Ferreira, O., and J.A. Morales, 2014. "Decadal morphological response of an ebb-tidal delta and down-drift beach to artificial breaching and inlet stabilisation." *Geomorphology*, *216*, 13-25.

GRBO, 2003. Dredging of Gulf of Mexico Navigation Channels and Sand Mining (Borrow) Areas Using Hopper Dredges by COE Galveston, New Orleans, Mobile, and Jacksonville Districts. Gulf Area Regional Biological Opinion (GRBO) issued to USACE South Atlantic, Mississippi Valley, and Southwest Divisions by National Marine Fisheries Service, St. Petersburg, Florida.

Hayes, M.O., and D. FitzGerald, 2013. "Origin, evolution, and classification of tidal inlets." *J. Coastal Research,* Special Issue 69 - Proceedings, Symposium in Applied Coastal Geomorphology to Honor Miles O. Hayes, 14-33.

Hein, C.J., Fitzsimons, G.G., FitzGerald, D.M., and A.R. Fallon, 2016. "Records of migration and ebb-delta breaching at historic and ancient tidal inlets along a river-fed paraglacial barrier island." In: Vila-Concejo, A., Bruce, E., Kennedy, D.M., and R.J. McCarroll (eds.), Proceedings of the 14th International Coastal Symposium (Sydney, Australia). *J. Coastal Research*, Special Issue, No. 75, 228-232. Coconut Creek (Florida), ISSN 0749-0208.

Hubbard, D.K., 1977. "Variations in tidal inlet processes and morphology in the Georgia Embayment." *Tech. Rept 14-CRD*, Coastal Research Division, Dept of Geology, Univ of South Carolina, Columbia, 79p.

Johnson, R.O., and W.G. Nelson, 1985. "Biological effects of dredging in an offshore borrow area." *Florida Scientist*, 166-188.

Kana, T.W., Traynum, S.B., and H.L. Kaczkowski, 2014. "Scales and signatures of episodic sand bypassing at a tide dominated inlet–Fripp Inlet, South Carolina." *Proc. 34th Conference of Coastal Engineering* (Seoul, South Korea, ASCE), 10p.

Kana, T.W., Traynum, S.B., Gaudiano, D., Kaczkowski, H.L., and T. Hair, 2013. "The physical condition of South Carolina beaches 1980–2010." In: Kana, T., Michel, J., and G. Voulgaris (eds.), Proceedings, Symposium in Applied Coastal Geomorphology to Honor Miles O. Hayes, *J. Coastal Research*, Special Issue No. 69, 61-82. Coconut Creek (Florida), ISSN 0749-0208.

Kana, T.W., 2002. "Barrier island formation via channel avulsion and shoal bypassing." *Proc. 28th International Conference on Coastal Engineering*, 3438-3448.

Kana, T.W., 1989. "Erosion and beach preservation at Seabrook Island, South Carolina." *Shore & Beach*, 57(3), 3-18.

Kraus, N.C., 2000. "Reservoir model of ebb-tidal shoal evolution and sand bypassing." *J. Waterway, Port, Coastal and Ocean Eng.*, 126(6), 305-313.

Maglio, C.K., Ousley, J.D., and J.L. Coor, 2015. "Sediment Engineering Through Dredging With Nature (SETDWN) — Fate of fines in the dredging and placement process." In *Proc. Coastal Sediments 2015*. https://doi.org/10.1142/9789814689977_0117

Mehta, A.J., Dombrowski, M.R., and P. T. Devine, 1996. "Role of waves in inlet ebb delta growth and some research needs related to site selection for delta mining." *J. Coastal Research*, 121-136.

Mrosovsky, N., 1994. "Sex ratios of sea turtles." *J. Experimental Zoology*, *270*(1), 16-27.

National Research Council, 1995. *Beach Nourishment and Protection*, Washington, DC: The National Academies Press. https://doi.org/10.17226/4984.

Rosov, B., Bush, S, Briggs, T.R., and N. Elko, 2016. "The state of understanding the impacts of beach nourishment activities on infaunal communities." *Shore & Beach*, 84(3), 51.

SARBO, 1997. "The Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States." South Atlantic Regional Biological Opinion (SARBO) issued to USACE South Atlantic Division by National Marine Fisheries Service, St. Petersburg, Florida.

Schrader, M.H., Douglass, E.C., and L.S. Lillycrop, 2016. "Regional sediment management strategies for the vicinity of St. Augustine Inlet, St. Johns County, Florida." U.S. Army Corps of Engineers, Engineer Research and Development Center report, *ERDC-CHL-TR-16-12*.

Seabergh, W.C., and N.C. Kraus, 2003. "Progress in management of sediment bypassing at coastal inlets: natural bypassing, weir jetties, jetty spurs, and engineering aids in design." *Coastal Engineering*, 45(4), 533-563.

Sexton, W.J., and M.O. Hayes, 1983. "Natural bar bypassing of sand at a tidal inlet." *Proc. Coastal Engineering '82*, ASCE, New York, NY, pp 1479-1495.

Suedel, B.C., Kim, J., Clarke, D.G., and I. Linkov, 2008. "A risk-informed decision framework for setting environmental windows for dredging projects." *Science of the total environment*, 403(1-3), 1-11.

Trudnack, M.E. 1997. Impacts on the Inlet-Beach System of Ebb Tidal Shoal Mining. Master's Thesis. Gainesville: University of Florida.

Traynum, S., and H. Kackowski, , 2015. "Evolution of a large-scale shoal-bypass event at Isle of Palms, SC — Implications for local beach management and shoreline predictions," In: *Coastal Sediments 2015,* Proceedings of the 11th International Symposium on Coastal Engineering and Science of Coastal Sediment Processes, San Diego, CA.

Walther, M.P., and B.D. Douglas,1993. "Ebb shoal borrow area recovery." *J. Coastal Research*, 211-223.

Welsh, J.M., and W.J. Cleary, 2007. "Evolution of a relocated tidal inlet: Mason Inlet, NC." In *Sixth International Symposium on Coastal Engineering and Science of Coastal Sediment Process*, 13-17 May 2007 , New Orleans, Louisiana, 1543-1556. https://doi.org/10.1061/40926(239)119

USACE, 2018. "Biological Assessment — Port Everglades Improvement Project." Prepared by the USACE Jacksonville District, 115p.

USACE, 2019a. "Carolina Beach, NC Beach Renourishment Evaluation Report." Wilmington District USACE, https://www.saw.usace.army.mil/Missions/Coastal-Storm-Risk-Management/Carolina-Beach, accessed 022 February 2020.

USACE, 2019b. "Wrightsville Beach, NC Beach Renourishment Validation Study Report." Wilmington District USACE, https://www.saw.usace.army.mil/Missions/Coastal-Storm-Risk-Management/Wrightsville-Beach, accessed 22 February 2020.

USACE RSM, 2019a. National Regional Sediment Management Program, https://rsm.usace.army.mil, accessed 22 February 2020.

USACE RSM, 2019b. USACE Navigation Sediment Placement: An RSM Program Database (1998-present), https://gim2.aptim.com/RSM, accessed 22 February 2020.

USACE RSM RCX, 2019. South Atlantic Division Optimization Pilot, USACE Regional Sediment Management, Regional Center of Expertise, https://www.sad.usace.army.mil/RSM-RCX, accessed 16 November 2019.

Sonu

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Multi-year ice: Recognizing their importance for the design of Arctic offshore facilities, Choule played a leading role in acquiring field measurements and modeling the dynamics of multi-year ice floes. While participating in one of the field programs, he was confronted by — and narrowly missed becoming a meal for — a polar bear.

Santa Monica breakwater: As principal oceanographic consultant for the reconstruction of the venerable Santa Monica Breakwater following the El Niño winter of 1982-83, Choule performed a detailed assessment of water levels, wave conditions, sediment transport, and historical shoreline changes at the project site.

INTERNATIONAL AMBASSADOR

Throughout his career, Choule used his linguistic capabilities and cultural understanding to forge bonds between the coastal engineering communities of the United States, Japan, and the Republic of Korea. He maintained particularly close ties with Professors Robert Wiegel of the University of California-Berkeley and Kiyoshi Horikawa of the University of Tokyo.

PASSING THE TORCH

Choule is survived by his wife of 60 years, Sunee; his three children, Christina Weiss, Charles Sonu, and Alex Sonu; his son-in-law, Steve Weiss; and four grandchildren. His professional legacy of boundless curiosity, hard work, and undying optimism will be carried on by those who worked with and learned from him.

Craig Leidersdorf is a principal and co-founder of Coastal Frontiers Corporation. He shared a professional affinity and personal friendship with Dr. Sonu for 35 years.

ASBPA's 13th annual photography contest

The editors of *Shore & Beach* announce the ASBPA's 13th annual photography competition. The purpose of the contest is to highlight the beauty and natural wonders of America's magnificent coasts as part of celebrating more than 85 years of continuous publication of *Shore & Beach*.

WHO CAN PARTICIPATE: The competition is open to all except ASBPA consultants and/or their immediate families (children, spouses, parents).

SUBJECT MATTER AND RULES:

Any photographs depicting the coastal zone are appropriate. These include, but are not limited to beaches, bluffs, marinas, wetlands, marine life, recreational facilities, and engineered projects as long as they include the setting in which they were built (i.e. no portraits of dredges or your favorite armor unit).

Manipulated photographs (colorized, posterized, solarized, etc.) are also welcome if the photographer briefly describes the changes or procedure. The original base photograph must have been taken by the submitter.

Submissions must be made in one of the geographic categories listed below.

Winning photographs may be used as cover art on *Shore & Beach*. Therefore, VERTICAL-format photographs are highly preferred. Horizontal photographs can be submitted, too, but if a horizontal format photograph is a winner in one of the categories below, the editors of ASBPA may have to crop some of the scene, at their sole discretion, to fit on the cover of *Shore & Beach*.

Photographs must have been taken since 1 January 2019. Photographs can be full-color, black and white, sepia, or colorized.

CATEGORIES:

- U.S. East Coast
- U.S. Gulf of Mexico Coast
- Caribbean (Puerto Rico, U.S. Virgin Islands)
- U.S. Pacific Coast and Alaska
- U.S. Great Lakes
- Pacific (Hawaiian Islands, Guam, etc.)

SUBMISSION: Participants are to send electronic files in JPEG, TIFF or BMP format to the following e-mail address: contest@ASBPA.org. Please send:

The full-size JPEG file as created in your camera (note, minimum camera resolution of 3 megapixels to allow for sufficient printing quality for cover art) or a reduced-size file (800x600 pixels minimum). Winners will have to send the full-size file later.

Each participant may submit up to five (5) photographs total. Photographers may submit all entries in a single category or select different categories as long as the total does not exceed five photographs.

Do not submit RAW files because there are too many manufacturer-specific formats. Convert RAW files to JPEG or TIFF files.

Also, please do not submit prints or transparencies of any size. ASBPA simply does not have the facilities to properly scan materials and handle the logistics of physical submissions.

In the text of the email, please include the following information:

1) Your name
2) Physical address
3) Email address
4) Occupation and place of employment
5) Photograph title or description
6) Date taken
7) Category (see list above)
8) Indicate if submission is full-size original or reduced size file for contest purpose.
9) Other notes if necessary (what is happening if it is an unusual scene, why you took the photograph, etc.).

WHEN: Deadline for submitting entries is 11:59 p.m. EDT on 30 September 2020.

PRIZES:

Winner in each category will have his (her) name and photograph printed in either *Shore & Beach* or the "Coastal Voice" e-newsletter, or both.

A Grand Prize winner will be selected from among the category winners to have his or her photograph printed on the cover of *Shore & Beach* and receive a one-year annual membership renewal to ASBPA.

Other entries of outstanding merit may be printed in "Coastal Voice," *Shore & Beach,* or on the ASBPA website. (Note: The editors may contact you for more information).

THE FINE PRINT:

LEGAL CONDITIONS:

By entering the contest, photographers agree to the following entry rules and conditions.

Your entry in the contest constitutes your agreement to allow your photographs and your name, occupation, city and state of residence to be published as a selected award winner in *Shore & Beach,* used on websites owned by the ASBPA or otherwise displayed or published in association with ASBPA and its activities. The American Shore & Beach Preservation Association retains permission in perpetuity for future use of the photographs in any and all ASBPA publications, materials, or activities.

Your entry in the contest also constitutes your agreement that your name, likeness, city, and winning photograph(s) may be used by ASBPA for promotional and publication purposes without compensation.

Participant warrants that his or her entry materials are original, do not infringe on any third party's rights, and that the participant has obtained any and all necessary permissions and releases from any third party if such third party appears in the photograph. Permission may not be needed for persons depicted in photographs taken in public settings such as crowded beaches where the purpose of the photograph is to show the overall setting or the environment.

ASBPA reserves the right, in its sole discretion, to disqualify any entry, and/or to not name winners in any category where photos of sufficient quality or quantity have not been received.

ASBPA reserves the right to alter the photographs submitted as it sees fit.

By entering, participants release and hold harmless the ASBPA and its officers, contractors, , attorneys, agents and representatives from any and all liability for any injuries, loss, claim, action, demand or damage of any kind arising from or in connection with the contest or any prize won, any use of the entry materials by ASBPA. .

ASBPA is not responsible for any incorrect or inaccurate information by any technical or human error that may occur in the processing of submissions to the ASBPA, including but not limited to any misprints or typographical errors.

ASBPA reserves the right at its sole discretion to cancel, terminate, modify, extend or suspend the contest.

ABBPA will not share or sell your personal information to any party, and winners' full addresses will not be printed.

All decisions by the ASBPA judges will be final and binding. Editors and officers of ASBPA will serve as the review and judging committee.