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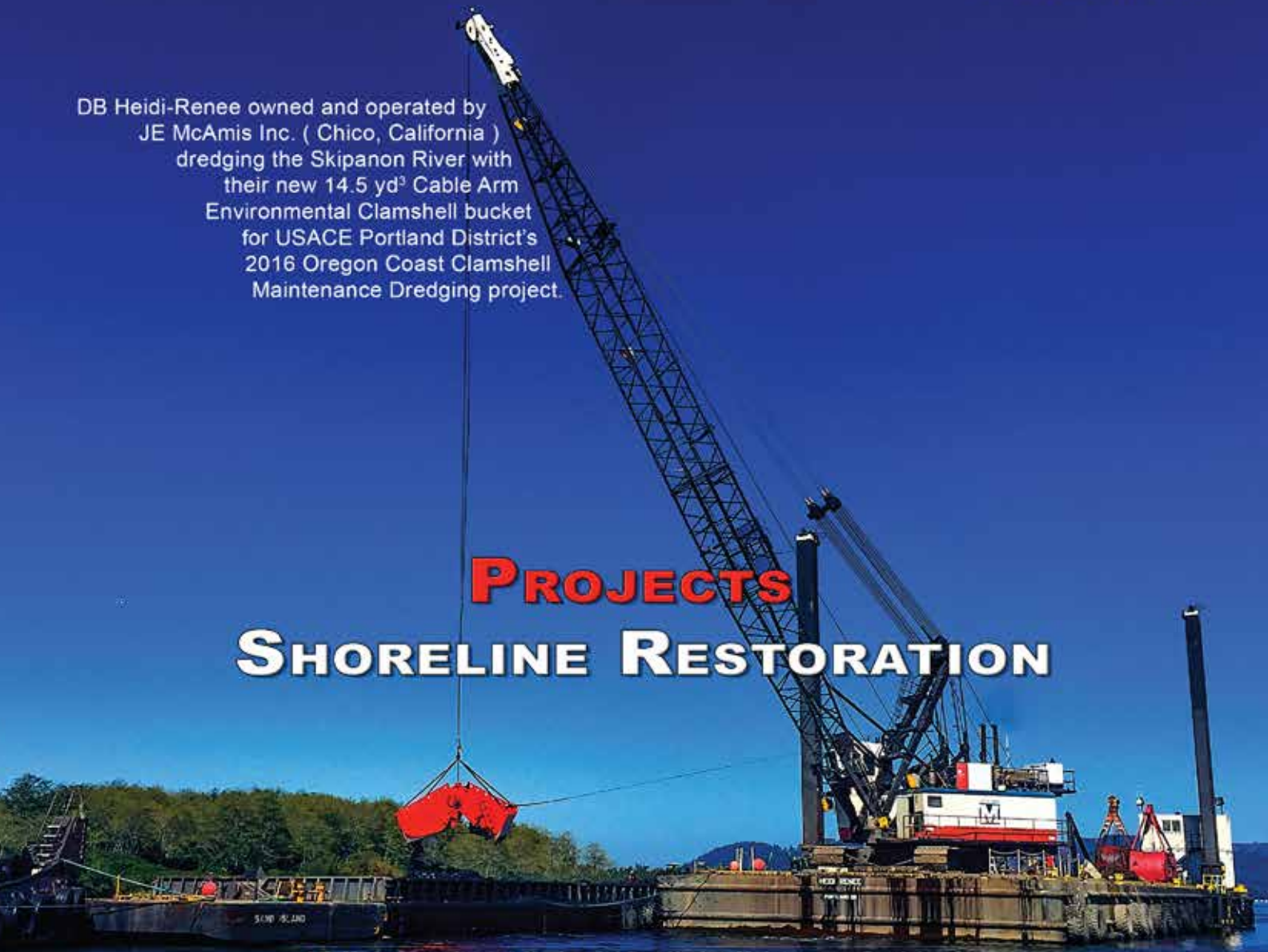

DB Heidi-Renee owned and operated by JE McAmis Inc. (Chico, California) dredging the Skipanon River with their new 14.5 yd³ Cable Arm Environmental Clamshell bucket for USACE Portland District's 2016 Oregon Coast Clamshell Maintenance Dredging project.

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Comparing Drone Technology to Conventional Methods for Beach Monitoring Surveys

Christian Stallings, CP, Research & Development Manager, McKim & Creed, Inc.

There's a buzz in the air…..literally. It's coming from an unmanned aerial system (UAS), more commonly referred to as a drone. By now you've probably heard it.

The residents of Wrightsville Beach, North Carolina heard it last spring when two national firms came together to test the efficacy of using UAS to collect data for beach monitoring surveys.

McKim & Creed and Esri conducted a proof of concept (POC) to test the accuracy, efficiency, cost effectiveness and environmental efficacy of using low-cost, commercial unmanned aerial systems (UAS) for beach monitoring surveys. Here, McKim & Creed's Christian Stallings, CP, (yellow vest) explains the UAS technology to representatives from local, state and federal agencies, as well as

The POC Premise

According to NOAA, shorelines constitute less than 10% of total land area in the U.S. but are home to 39% of the nation's population. Nearly 130M people live in communities that depend on accurate, cost-effective beach monitoring surveys to maintain healthy coastlines.

Coastal communities prepare for a land-falling storm event year round. Most municipalities that have oceanfront assets have a beach management plan, which is required for communities that have or are seeking federal funds to help maintain their beaches. Included in the plans are beach monitoring surveys. These are performed twice per year to capture current, existing conditions of the beach. Comparing the surveys helps engineers analyze the beach's performance in terms of erosion and accretion, and plan and predict maintenance and renourishment events. In the case of a storm event where significant loss of beach occurs, these surveys can be used to help secure emergency funding for restoration.

McKim & Creed field crews collected blind checkpoints at the site to independently verify the accuracy of the UAS data.

Data is typically collected using terrestrial LiDAR, aerial LiDAR, and/or conventional surveying technologies.

On May 16, 2016 during National Hurricane Preparedness Week, national engineering, surveying and planning firm McKim & Creed, Inc., headquartered in Raleigh, North Carolina, teamed with Redlands, California-based Esri, the world's largest geographical information systems (GIS) company. The two companies performed a proof of concept (POC) to determine if UAS technology could provide coastal communities with a faster, more cost-effective, and more environmentally friendly way to produce beach monitoring surveys.

Representatives from local, state and federal agencies, as well as UNC Wilmington, Audubon Society and NC Land Trust, were onsite to observe the test flights and data collection. The processed data and results of the study were presented to the observers the following day.

The data was processed in Esri's Drone2Map software. Blue dots represent the location each image was taken and the 3D model is laid over existing imagery.

The test site included two rock jetties. The inset is the 3D model produced from the UAS data, and the background image is a photo of the jetty taken by the drone.

The Site

The test site for the UAS POC covered approximately 100 acres along Wrightsville Beach, North Carolina and included two rock jetties.

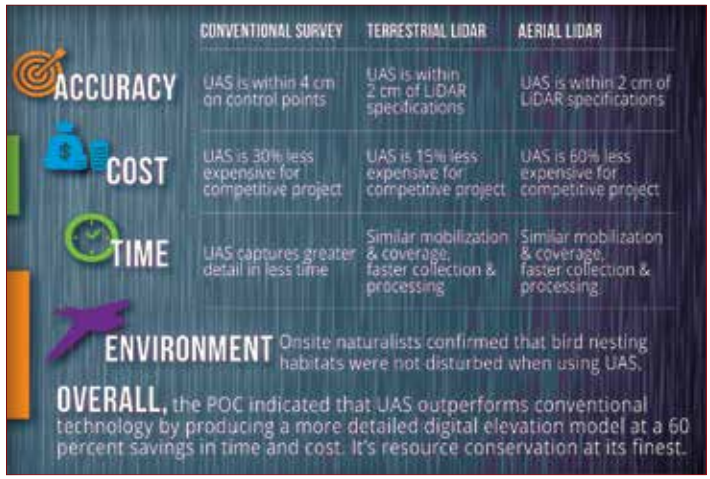
This area is prone to erosion and is surveyed regularly to accurately measure and map the erosion and determine the urgency of beach renourishment programs. Such erosion can cause costly property damage and disturb environmentally sensitive shore bird nesting areas.

The Technology

The POC showcased Esri's Drone2Map software, which processes imagery collected by UAS into an accurate, usable dataset that can be seamlessly imported into Esri's GIS mapping platform. McKim & Creed, which was operating under FAA Section 333 and has a long history of performing coastal surveys using conventional methodologies, performed the UAS data acquisition. This included filing a flight plan with the FAA, setting ground control, working with the local municipality to help secure the test areas during the data collection, and flying the site.

McKim & Creed conducted four data-collection flights. Two flights were flown with the 3DR Solo UAS equipped with a Sony R10C camera with 16-mm prime lens (operating altitude of 400 ft. above ground level [AGL], 1.21 inches ground sampling distance [GSD]). To compare the accuracy of various drone cameras, one flight was flown using a Solo/GoPro Hero 4 Black edition setup (400 ft. AGL 2.44 inch GSD), and another was flown with a Phantom 4 (200 ft.AGL 1.01 inch GSD). The same day, a federal agency used terrestrial LiDAR to collect data in the same area.

To verify accuracy, McKim & Creed field crews surveyed 14 targets on the beach using virtual reference station (VRS) double occupancies, and collected 22 blind check shots in random locations. Esri processed the data using its Drone2Map software, and compared it with data collected via aerial LiDAR, terrestrial LiDAR and conventional surveying on the basis of accuracy, cost, delivery time and environmental efficacy.



The UAS data was compared with data collected of the same site via terrestrial LiDAR, aerial LiDAR and conventional surveying. Overall, the POC indicated that UAS, a highly accurate, non-invasive technology, outperforms conventional technology by producing a more detailed digital elevation model at a 60% savings in time and cost. Just as importantly, it does not disturb wildlife and bird habitats.

The Results

The data comparison showed that, in the correct environmental conditions such as open beaches or moderately vegetated berms and basins, UAS outperforms conventional services by producing a more detailed digital elevation model (DEM) more quickly and at a lower cost. Specifically, the 3D results provided an accuracy of 2.5 cm (about one inch), which far surpassed the conventional accuracy of approximately 6.5 inches.

The POC team in a photo taken by the drone. The UAS proof of concept was named the "2017 Grand Conceptor" engineering excellence award winner by the North Carolina Chapter of the American Council of Engineering Companies. The Grand Conceptor is highest award given in the engineering excellence awards program.

With UAS the McKim & Creed/Esri team was able to provide a detailed elevation model with 3D points every few inches, rather than a more traditional map showing cross sections every few hundred feet. Overall, the team estimated that UAS provided up to a 60% savings in time and cost when compared to conventional techniques for beach monitoring surveys. UAS also required fewer people, offered greater safety to crews, provided higher accuracy, produced a faster deliverable, and did not disturb bird nesting or other coastal wildlife habitats.

The data that was collected was used to create a profile of Wrightsville Beach's pre-hurricane season condition, which can then be compared to a profile developed in the event of a storm. A federal agency was able to use the UAS imagery collected from the jetties to verify work that had recently been conducted by a subcontractor. Using the UAS imagery, the agency determined that most new rocks had been placed correctly; however, some were not. This allowed the agency to return to the contractor to make the necessary corrections. It would not have been possible to quickly gather this information by any means other than UAS.

About McKim & Creed

McKim & Creed is an employee-owned engineering, surveying and planning firm with nearly 400 staff members in offices throughout the U.S., including North Carolina, Florida, Virginia, Georgia, Texas, and Pennsylvania. Mcim & Creed specializes in civil, environmental, mechanical, electrical, plumbing, and structural engineering; industrial design-build services; airborne and mobile LiDAR/scanning; unmanned aerial systems; subsurface utility engineering; and hydrographic and conventional surveying services for the energy, transportation, federal, land development, water and building markets. The firm was recently ranked the #1 surveying and mapping firm in the U.S. by ENR Southeast magazine. For more information about McKim & Creed, visit www.mckimcreed.com.

About Esri

Esri is an international supplier of geographic information system software, Web GIS and geodatabase management applications. www.esri.com.